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INSECTICIDE INVESTIGATIONS BRANCH

R. W. Fay, W. C. Baker, R. H. McCauley, H. I. Scudder,
R. Reiber[1], J. Clapp[2], E. Cole, A. Buckner

Adult Mosquito Control Studies (Laboratory)

Previous work has been reported from this laboratory on the residual effectiveness of DDT deposits on different types of surfaces. In order to extend this study as far as practicable several additional surfaces encountered in residual spraying were placed on test. Limited tests were made with DDT water-miscible powder suspensions on surfaces to which this type of application might be practical and a few surfaces were tested with DDT-kerosene solutions. The results of these tests run in duplicate are shown in table 1.

The plywood panel surface has been adopted as a standard of comparison in these tests. It may be noted that the initial effectiveness of the 5 percent DDT-xylene-emulsion is not as high on the smooth impervious surfaces of aluminum, glass, glazed concrete and tile as it is on the plywood, corroded metal or bamboo. On the plexiglass the xylene may have had some action although it was not evident on gross examination.

The presence of rust on the sheet tin and metal screen has not yet caused any deterioration in the residual effectiveness. On all surfaces tested with the exception of the rusty metal screen, the water-miscible

1/ Resigned September 13, 1946

2/ Resigned August 10, 1946

Table 1. Twenty-four hour mortalities (percent) of adult female A. quadrimaculatus mosquitoes after 60 minute exposure periods to 200 mg. DDT per sq. ft. residues applied to various types of surface materials and tested at different intervals after application. Deposits were applied as 5 percent DDT-xylene-Triton X-100 emulsion, 5 percent DDT-Kerosene solution and 5 percent DDT water-miscible powder suspensions. Results are based on duplicate panels.

	Type of Spray								
	DDT-Xylene Emulsion				H_2O Misc. Powder		DDT-Kerosene Solu.		
Age of Residue (weeks)	4	6	8	14	4	12	4	8	14
Type Surface									
New Sheet Aluminum	83	-	82	69	92	96	80	63	47
Rusty Sheet Tin	100	-	94	84	--	--	79	78	87
New Metal Screen	100	-	90	83	--	--	--	--	--
Rusty Metal Screen	--	100	97	98	86	71	--	--	--
Glass	74	-	78	73	92	88	--	--	--
Plexiglass	47	-	63	57	--	--	86	77	77
Dry Bamboo	94	--	97	100	100	98	72	73	74
Palmetto Thatch	--	--	--	--	76	79	--	--	--
3:1 Concrete	70	--	39	27	98	98	--	--	--
Glazed Tile	83	--	75	70	92	88	--	--	--
Mud	--	--	--	--	12	4	--	--	--
Plywood Panel	98	--	89	88	86	--	86	78	71
Green Bamboo	--	--	--	--	84	80	82	70	60

5 percent DDT powder suspension is equal to or more effective than the DDT-xylene emulsion deposit. It should be noted that little residual toxicity was shown by the water-miscible DDT powder on the mud surface tested. The kerosene-DDT solution has better spreading power on smooth surfaces than the DDT-xylene emulsion and appears somewhat superior on the plexiglass surface. Fairly poor results were obtained on the green bamboo and palmetto thatch as the protective plant wax coverings tend to peel when treated with residual sprays.

Effects of Surface Treatment on Residual Deposits.

There has been considerable variation in the effectiveness of DDT residual deposits in occupied and unoccupied rooms. In occupied rooms much available resting area for mosquitoes is furnished by clothing, drapes, overstuffed furniture and other fabric surfaces which have been untreated in the spray program. In order to determine any physical or chemical effect of spray application on different types of fabric and the effect of normal cleaning operations on the DDT residual deposits a series of fabric panels were prepared in duplicate and after spray application were subjected to cleaning operations. The results of these tests are shown in table 2.

Gross examination of the fabrics after application of a 5 percent DDT - 4 percent Triton X-100 - xylene emulsion at the rate of 4 cc. per sq. ft. failed to reveal any spotting, shrinking or any chemical deterioration. It is interesting to note however that the initial effectiveness of the DDT was not as high on the plastic materials, i.e., rayon, celanese, and nylon, as it was on the plant and animal fiber materials.

Table 2. Twenty-four hour mortalities (percent) of adult female A. quadrimaculatus mosquitoes after 60 minute exposure periods to 200 mg. DDT per sq. ft. residues applied to various cloth materials and subjected to various surface treatments. Results are based on duplicate panels.

Surface Material	Treatment	Age of Residue (Weeks) 4	6	10	14
Cotton goods	None	94	81	84	87
	Laundered (5 & 11)*	95	68	87	62
	(5 & 11) Laundered & Ironed	93	42	31	20
Rayon	None	78	49	58	54
	Dry Cleaned (5 & 11)	52	31	16	11
Celanese	None	47	35	39	46
	Dry Cleaned (5 & 11)	42	37	30	21
Mohair	None	98	86	88	90
	Dry Cleaned (5 & 11)	93	34	21	9
	Brushed (5 & 11)	82	81	53	38
	Vacuum Cleaned(5 & 11)	100	76	75	73
Nylon	None	79	51	46	32
	Dry cleaned (5 & 11)	57	59	39	19
Chintz	None	94	75	76	83
	(5 & 11) Sponged & Ironed	100	77	77	79
Slip Cover Material	None	99	76	83	92
	Dry cleaned (5 & 11)	97	96	83	45

*Figures in parentheses refer to week of aging that surface treatments were applied.

This suggests that more DDT is retained by the rougher natural fibers than by the smoother synthetic fibers.

Dry cleaning with mineral spirit naphtha caused the residual toxicity to drop markedly. This loss probably resulted from the solvent action of the cleaner on the DDT crystals. Carbon tetrachloride should give the same type of results when used as the dry cleaning agent.

Laundering appears to have little effect in removing the DDT residues. Ironing on the other hand may be an important factor. The chintz material was ironed with a low heat iron and did not lose much residual toxicity. The cotton goods were pressed with a hot iron and the deterioration of residual effectiveness was marked.

Cleaning with a vacuum sweeper changed the residual toxicity somewhat but vigorous hand brushing with a whisk broom had more effect.

Adult Mosquito Control Studies (Field)

Enough comparative field tests of different insecticides have been made so that a preliminary evaluation of five types of treatment can be presented here.

Fifteen identical rooms were used, each containing equal surface areas of painted concrete block, wood and wall board. Each of the residual sprays used was applied to the walls and ceiling of the rooms at the rate of 200 mg. of insecticide per sq. ft. All applications were made by one operator using the same sprayer equipped with the same 50-02 nozzle. The nozzle was calibrated and the correct application rate achieved by timing the spraying of each room.

Tests were carried out by observing for a four hour period the reactions of insectary-reared A. quadrimaculatus mosquitoes liberated in each test room. The number of mosquitoes released in each test approximated slightly less than 500 adults. A sample from each cage of insects used was retained during the test as a check on the condition of the mosquitoes. Counts of knocked down mosquitoes of each sex were made at 20 minute intervals but only the results on the female adults are presented. At the end of the test any mosquitoes remaining were also counted. During the first series of tests the knocked down mosquitoes were held in cages for 24 hours to determine any recovery rate. At no time were any of these insects noted to recover and this procedure was abandoned. Mosquitoes which had been exposed but not knocked down were destroyed after counting. These tests, therefore, are intended as a measure of the comparative effectiveness of surface residues of five insecticide combinations in terms of the rate of knockdown over a period of four hours.

The insecticides used were 5 percent "1068"3/-kerosene-Triton X-100 emulsion, and 5 percent DDT, DDD, "1068" and technical grade "3956"4/-xylene-Triton X-100 emulsions respectively. Each room, with the exception of those treated with "3956", was tested three times and the data obtained from each set of three rooms were averaged. In table 3 the general data from these tests are summarized. The most useful criteria indicated here

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3/ "1068" is a chlorinated hydrocarbon produced by the Velsicol Corp., Chicago, Ill.

4/ "3956" is a chlorinated terpene hydrocarbon produced by the Hercules Powder Co., Wilmington, Delaware.

Table 3. Comparative time periods required for different percentages of knockdown of adult female *A. quadrimaculatus* mosquitoes when released in test rooms treated with various insecticides. Figures are averages of three rooms each.

Insecticide 200 mg/sq. ft.	DDT			DDD			"1068"			"1068"			"3956"	
Solvent	Xylene			Xylene			Xylene			Kerosene			Xylene	
Test Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2
(Days) Average Age	22.6	40.6	103	17.3	45.3	95	22.6	53.6	108.6	28	53.6	109.6	20	78.3
(Days) Age Range	18-28	45-56	99-108	15-21	42-51	88-105	21-24	51-57	106-113	27-29	48-57	101-115	19-21	75-82
Number Minutes For Greatest KD	73.3	66.6	76.6	106.6	140	126.6	113.3	100	180	80	93.3	160	180	240
Number Minutes For 50% KD	73.3	83.3	86.6	126.6	200+	160	106.6	90	173.3	83.3	100	156.6	180+	226.6+
Number Minutes For 100% KD	220	240+	233.3+	240+	240+	240+	220	233.3	240+	213.3	226.6+	226.6	240+	240+

are the figures showing the time when the greatest knockdown was observed, and the figures showing the number of minutes necessary for a 50 percent knockdown.

On the basis of three releases DDT appears superior to the other insecticide treatments in speed of knockdown and lasting quality. Of the two "1068" emulsions tested kerosene was better than xylene as a solvent. The "1068"-xylene emulsion was comparable to DDD but showed more rapid action. The apparent improvement in potency of DDT and "1068"-xylene and the decrease in action of DDD in the second test cannot be explained with certainty. The insecticide "3956", at least in the form used, appears inferior as a residual spray. "3956" was applied comparatively late in the season and only two series of tests have been made. These indicate that it is very slow acting, even when newly applied. At an average age of 20 days the "3956" residue compared unfavorably with "1068"-xylene at 108 days.

In table 3 it may further be noted that on the last series the time necessary for a complete knockdown was less than four hours only for DDT and "1068"-kerosene treatments. Thus, in terms of 100 percent kill "1068" seems about the same as DDT over the period tested.

In a further effort to evaluate differences in these spray applications (table 4) the loss of effectiveness over a period of time is shown for each insecticide used. This loss is expressed as the difference in the number of minutes necessary to reach the greatest knockdown, 50 percent knockdown and 100 percent knockdown. It will be noted again that DDT is clearly superior except in terms of 100 percent knockdown and then is closely approached in effectiveness by "1068"-kerosene. On the basis of the averages shown DDD and "3956" do not secure a 100 percent knockdown in four hours.

Table 4. Comparative differences (minutes) in various rates of knockdown of adult female A. quadrimaculatus between 3 week old and 3 month old 200 mg. per sq. ft. residues of various insecticides. Results are averages of three rooms each.

Insecticide	DDT-Xylene	DDD-Xylene	"1068" Xylene	"1068" Kerosene	"3956" Xylene
Additional Minutes For Greatest KD	3.3	20	66.7	80	60
Additional Minutes For 50% KD	13.3	33.3	66.7	73.3	46.6
Additional Minutes For 100% KD	13.3	—	20	13.3	--

The relative action of these insecticides may be further compared (table 5) by the cumulative average percentages of mosquitoes knocked down at the end of each hour during the four hour exposure. It is apparent from this that DDT, though more rapid in action than "1068", is not significantly superior on the basis of four hour exposures. Both DDD and "3956" have fair knockdown qualities but are much slower in action than either of the above two.

Table 5. Cumulative percentage of knockdown of adult female A. quadrimaculatus mosquitoes at the end of one hour periods after exposure to residual deposits of various insecticides ranging in age from 3 weeks to 3 months. Results are averages of three rooms each.

Insecticide 200 mg/sq. ft.	DDT			DDD			"1068"			"1068"			"3956"	
Solvent	Xylene			Xylene			Xylene			Kerosene			Xylene	
Test Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2
1st Hour	45.6	36.43	31	11.23	3.16	6.53	8.26	7.1	2.13	20	12.5	1	1.13	2.36
2nd Hour	90.26	85.76	76	54.56	23.82	34.19	64.26	92.43	18.79	94.33	83.8	34.96	14.59	6.66
3rd Hour	97.82	96.42	92	76.89	52.15	61.52	96.86	98.09	60.12	98.79	98.1	68.62	59.25	23.19
4th Hour	100	99.45	97.8	87.12	68.15	81.85	100	100	93.78	99.39	99.66	98.42	80.58	51.19
% Remaining	0	.6	1.3	13	31.66	17.6	0	0	5.66	0	.1	1.6	20	50

Housefly Control Studies (Laboratory)

Adults.

Preliminary observations demonstrated that a 25 mg. DDT per sq. ft. deposit lost residual effectiveness more rapidly against the housefly, *M. domestica*, than against the mosquito, *A. quadrimaculatus*, and that results obtained with mosquitoes as the test insects could not be used to predict directly results as to DDT efficiency in housefly control.

This statement was further substantiated in a series of experiments testing the effectiveness of 50, 100 and 200 mg. DDT per sq. ft. deposits against *M. domestica* over a period of 22 weeks. Fifteen and thirty minute exposure periods gave the kills of male and female adult houseflies shown in table 6.

The fifteen minute exposure periods gave earlier differentiations than the thirty minute exposure periods but the latter reflect more closely the field results. As shown in table 6, the 50 mg. DDT per sq. ft. residue lost effectiveness rapidly after 8 weeks, the 100 mg. DDT per sq. ft. residue gave better than 80 percent control for 14 weeks, while the 200 mg. DDT per sq. ft. residue was only slightly better showing more than 80 percent control for 16 weeks. It is interesting to note that with 15 minute exposures of female flies the effectiveness shows rapid deterioration in all cases once the change starts.

Although it was previously reported (Summary of Activities No. 6, Second Quarter 1946) that the residual effectiveness of 200 mg. DDT per sq. ft. deposits was not influenced by change in the emulsion within the range of 2 1/2 to 10 percent DDT, extended studies over a 20 week period

Table 6. Twenty-four hour mortalities (percent) of adult male and female, *M. domestica*, after 15 and 30 minute exposures to 50, 100 and 200 mg. DDT per sq. ft. deposits on plywood surfaces. Results based on duplicate panels.

Conc. DDT Mg./sq.ft.	50				100				200			
Exposure Period (Minutes)	15		30		15		30		15		30	
Sex.	M	F	M	F	M	F	M	F	M	F	M	F
Age of Deposit (weeks)												
1	95	82	100	100	99	94	98	96	99	95	100	97
4	95	92	100	100	98	97	97	97	99	98	100	99
6	97	88	100	99	99	99	99	99	100	94	100	100
8	99	57	100	95	98	88	100	98	100	81	100	100
10	95	20	100	75	96	55	99	93	99	61	100	96
12	68	5	100	42	95	19	99	87	97	44	100	91
14	37	2	100	18	94	7	98	84	88	28	100	89
16	39	4	99	17	83	6	96	67	76	18	100	83
18	49	8	91	24	67	3	93	45	75	17	99	64
20	51	7	88	22	65	2	95	44	74	12	98	45
22	58	4	88	11	69	3	98	54	78	6	98	41

have demonstrated that the residues from the 2 1/2 percent DDT emulsion were slightly better on rough wood and appreciably better on wallpapered surfaces. Results of the extended tests are shown in table 7. On rough wood surfaces there was little difference between any of the concentrations for the first ten weeks after which time the 2 1/2 percent DDT emulsion was slightly better than the 5 and 10 percent applications. The difference in effectiveness on wall paper was noted after six weeks.

Larvae.

Preliminary screening tests of seven insecticides were made in the laboratory to determine their relative effectiveness as fly larvicides. The test insects used were nearly mature fly larvae, which were allowed to remain undisturbed in the artificial medium in which they were being reared. About 250 newly-hatched housefly larvae (15 mg.) were placed in each of several 600 cc. beakers half full of new medium and kept at insectary conditions for three days at which time they were nearly mature and ready for testing.

Dusts were applied in dusting chamber in which the number of mgs. per square foot was calculated. Sprays were added dropwise by a serological pipette, and uniform coverage seemed easily obtainable since 3.2 cc was the amount of a 2 1/2 percent spray applied to each jar (to achieve a dosage of 1200 mg. of pure insecticide per square foot).

On a few of the early tests, sand was added when the surviving larvae were mature, but as this caused them to "work over" the sprayed surface and mix the sand into it, the addition of sand was discontinued. Adult emergence in two cases (DDD and DDT) seemed to differ greatly with respect

Table 7. Twenty-four hour mortalities (percent of adult female, M. domestica, after 30 minute exposure periods to 200 mg. DDT per sq. ft. deposits from applications of 2 1/2, 5 and 10 percent DDT-xylene emulsions on plywood, rough wood and wallpaper surfaces.

Surface	Plywood			Rough wood			Wallpaper		
Conc. DDT-xylene emul. (%)	10	5	2 1/2	10	5	2 1/2	10	5	2 1/2
Age of Residue (weeks)									
1	100	99	100	100	98	100	100	100	99
2	100	99	100	100	99	99	97	99	99
4	99	100	100	100	99	99	85	94	99
6	99	99	100	99	99	99	62	75	99
8	99	93	81	99	100	100	31	39	97
10	99	87	43	99	100	99	17	10	82
12	79	90	35	84	95	97	18	3	62
14	58	93	56	65	89	96	9	15	59
16	70	85	61	73	86	97	5	27	75
18	75	58	54	78	78	99	22	25	85
20	65	32	47	71	69	99	40	20	88

to the addition of sand so it was subsequently omitted. It is possible that these two compounds exerted a residual effect on the surviving larvae when they reworked the treated surface.

These preliminary laboratory tests (as shown in table 8) indicated that the gammexane and "3956" were likely to be excellent fly larvicides, Velsicol "1068" also shows promise, although its prolonged slow larval "kill" would bear investigating. DDD and DDT seemed to affect the larvae in much the same way, but DDD was less toxic. Ortho-dichlorobenzene at the dosage tested (1200 mg./sq. ft.) gave negligible effects, while "899" (di-2-ethyl hexyl phthalate) had no observable effect at all on the fly larvae.

Though ortho-dichlorobenzene is acknowledged as a fly larvicide in use at the present day, 1200 mg. (about 1 cc) per square foot is far below its recommended usage (about 15-25 cc), and this accounts for its failure in the tests given here.

As little difference could be observed between the effects of the 600 mg. and 1200 mg. dosages of gammexane and "3956", it was considered well to run field tests on 10 percent dusts aimed at about 900 mg. per square foot to give a good margin for error.

Housefly Control Studies (Field)

Adults.

In a group of vacant cement block houses, identically constructed rooms were treated with emulsions or suspensions containing 5 percent of various candidate insecticides. Application was at the rate of 200 mg active ingredient per square foot.

Table 8. Laboratory tests of housefly larvicides using 15 mg. (about 200 to 250 larvae) per test.

Insecticide	Per-cent used	Form	Components	Dosage (net) /sq. ft.	24 hr. effects	Pupation	Emergence No. of Adults	Remarks
Hercules "3956"	2 1/2	emulsion	Triton X-100 Xylene	1200	Many affected and shock sensitive.	1	0	Excellent, 10% dust suggested for trial.
Hercules "3956"	25	dust	Pyrophyllite	1200	Many affected and shock sensitive.	1 poorly formed.	0	
Hercules "3956"	25	dust	Pyrophyllite	600	Many affected and shock sensitive.	1 poorly formed.	0	
Dupont "Gammexane"	50	dust	Pyrophyllite	1200	Many affected and moribund.	A few poorly formed	0	Excellent, 10% dust suggested for trial.
Dupont "Gammexane"	10	dust	Pyrophyllite	600	Great many affected and moribund.	2 poorly formed	0	
Velsicol "1068"	2 1/2	emulsion	Triton X-100 Xylene	1200	Many affected.	?	0	Slow to kill, but promising.
DDT	2 1/2	emulsion	Triton X-100 Xylene	1200	Many hyperactive. No kill	Large No.	66	Erratic kill, poor
Rohm & Haas DDD	2 1/2	emulsion	Triton X-100 Xylene	1200	No effects observed.	Large No.	188	Poorer than DDT
American Cyanamid "899"	2 1/2	emulsion	Triton X-100	1200	No effect observed.	Large No.	275	Not effective
O-dichloro-benezene	2 1/2	emulsion	Triton X-100	1200	No effects observed.	Large No.	123	Not effective
Solvent check	(rate) 2 1/2	emulsion	Triton X-100 Xylene	(rate) 1200	No effects observed.	Large No.	182	All
Untreated check	-	-	-	-	None.	Large No.	167	Valid

Monthly releases of approximately 500 insectary-reared houseflies were made in each of two rooms treated with the insecticide. At 20 minute intervals, for a four hour period, inspections were made in each room and the number of flies "knocked down" were collected and counted. A number of the flies knocked down were held for 24 hours to determine if any recovery occurred.

An effort was made to incorporate DDT in a water paint (Kemtone) so that a one-coat application gave a 400 mg DDT per square foot deposit. In one set of tests a DDT-acetone solution was added to the paint, while in a second set a 50 percent water-dispersible DDT was used. In each set the ceiling only, the walls only, and a complete treatment (walls and ceiling) were applied to separate rooms.

Tests were also made on a wallpaper impregnated with DDT at the rate of 100 mg per square foot. One room was prepared with paper on the walls only, while a second room had both the ceiling and the walls papered.

Table 9 gives a rating of the various insecticides based arbitrarily on the number of minutes required to obtain 50 percent and 100 percent knock-down.

During the season limited studies have been in progress to determine the residual effectiveness of "1068" for the control of houseflies in dairy barns. In dairy #11, which had not been in use for several years prior to this spring, a "1068" xylene-Triton X-100 emulsion containing 2 1/2 percent "1068" was applied to the milking barn at the rate of 200 mg "1068" per sq. ft. In the two weeks in which the barn was used prior to treatment on May 21, the average of two weekly housefly indices was 16.6

Table 9. Rated effective residual toxicity of various insecticides against the housefly based on minutes required for knockdown of 50 percent and 100 percent three months after application.

Rated Number	Spray Material Under Test		Degree of Room treated	Minutes required for	
				50% K.D.	100% K.D.
1	DDT-Xylene-Triton Emul. on Kemtone Surface		Complete	45	100
2	DDT (90%) water dispersible (DuPont)		Complete	55	120
3	DDT-Xylene-Triton Emul. on Kemtone Surface		Walls only	48	140
4	Neocid D-30 (Geigy)		Complete	73	180
5	"1068" Xylene-Triton Emulsion		Complete	88	170
6	Neocid M-25 (Geigy)		Complete	73	210
7	"1068" Kerosene emulsion		Complete	120	170
8	DDT (50%) water dispersible (Genitox)		Complete	106	+**
9	DDT-acetone in Kemtone	*	Complete	124	+
10	DDD-xylene-Triton X-100 emulsion		Complete	200	+
11	DDT-xylene-Triton X-100 emulsion		Ceiling only	240	+
12	"3956" water dispersible (Hercules)		Complete	+	+
13	"3956" xylene-Triton emul.		Complete	+	+
14-20	DDT-acetone in Kemtone	*	Walls only	+	+
	DDT-acetone in Kemtone	*	Ceiling only	+	+
	DDT-water dispersible in Kemtone	*	Complete	+	+
	DDT-water dispersible in Kemtone	*	Walls only	+	+
	DDT-water dispersible in Kemtone	*	Ceiling only	+	+
	DDT impregnated wall paper	***	Complete	+	+
	DDT impregnated wall paper	***	Walls only	+	+

* Applied at rate of 400 mg. DDT per sq. ft.
** Required more than 4 hours.
*** 100 mg DDT per sq. ft.

Table 9. Rated effective residual toxicity of various insecticides against the housefly based on minutes required for knockdown of 50 percent and 100 percent three months after application.

Rated Number	Spray Material Under Test	Degree of Room treated	Minutes required for	
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2	DDT (90%) water dispersible (DuPont)	Complete	55	120
3	DDT-Xylene-Triton Emul. on Kemtone Surface	Walls only	48	140
4	Neocid D-30 (Geigy)	Complete	73	180
5	"1068" Xylene-Triton Emulsion	Complete	88	170
6	Neocid M-25 (Geigy)	Complete	73	210
7	"1068" Kerosene emulsion	Complete	120	170
8	DDT (50%) water dispersible (Genitox)	Complete	106	+**
9	DDT-acetone in Kemtone *	Complete	124	+
10	DDD-xylene-Triton X-100 emulsion	Complete	200	+
11	DDT-xylene-Triton X-100 emulsion	Ceiling only	240	+
12	"3956" water dispersible (Hercules)	Complete	+	+
13	"3956" xylene-Triton emul.	Complete	+	+
14-20	DDT-acetone in Kemtone *	Walls only	+	+
	DDT-acetone in Kemtone *	Ceiling only	+	+
	DDT-water dispersible in Kemtone *	Complete	+	+
	DDT-water dispersible in Kemtone *	Walls only	+	+
	DDT-water dispersible in Kemtone *	Ceiling only	+	+
	DDT impregnated wall paper ***	Complete	+	+
	DDT impregnated wall paper ***	Walls only	+	+

* Applied at rate of 400 mg. DDT per sq. ft.
** Required more than 4 hours.
*** 100 mg DDT per sq. ft.

flies while in the 4 month period subsequent to treatment the average of the weekly indices was 3.9 flies.

In dairy #12, similarly treated to dairy #11, the average of the weekly housefly indices taken by the grill method during the month of May was 68.8 houseflies. In the four months period subsequent to treatment on June 3 the average of the weekly indices was 3.8 flies.

At a third dairy, the milking barn had been given a special coat of white wash in late August 1945 and then treated with DDT in early September to determine the effectiveness of this combination in controlling the flies during the following season. During the spring of 1946 the desired control was not obtained with the sanitary conditions prevailing, and from late April to late July the average of the weekly indices was 16.0 houseflies. On July 29 the milking barn was treated with a "1068"-xylene-Triton emulsion containing 1 1/4 percent "1068". Application was made at the rate of 100 mg. "1068" per sq. ft. In the two months period subsequent to treatment, the average of the weekly housefly indices was 3.5 flies.

An assay for the control of blowflies with "1068" has been made at two abattoirs and an isolated hog corral. In all cases a "1068"-xylene-Triton X-100 emulsion containing 2 1/2 percent "1068" was used and the spray material was directed toward the resting places of the blowflies, i.e. the nearby trees and shrubbery. In all locations the predominate fly was *Cochliomyia macellaria*.

In abattoir #4 the weekly indices were somewhat variable but during May, June and July they averaged 48.6 blowflies. In the two month period subsequent to treatment on August 1st, the average was 7.7 blowflies.

In abattoir #5 the average of the weekly indices during June and July was 16.6 blowflies while in the two month period following treatment the average was 2.0 blowflies.

At the pig corral the average of the weekly indices during late April and May was 405.3 blowflies. At this location seafood wastes were dumped two to three times a week for hog feed. The lower parts of the several small trees within 25-30 feet of the waste pile were treated. For a 15 week period subsequent to treatment, the average of the weekly blowfly indices was 24.0 flies in spite of the fact that weekly investigations of the seafood waste pile revealed a very heavy larval population.

In two dairy barns DDT was mixed with whitewash and applied to the milking barn with a power sprayer at the rate of 400 mg DDT per sq. ft. In dairy #3 a 50 percent water-dispersible DDT was added to the whitewash immediately after mixing. In a pretreatment period of six weeks from mid-April through late May, the average of the weekly indices was 13.6 houseflies while during the posttreatment period of 18 weeks from May 27 through September the average of the weekly indices was 3.8 houseflies.

In dairy #4 a DDT-xylene-Triton concentrate containing 35 percent DDT was added to the whitewash immediately after it was mixed and was applied to the milking barns at the same dosage and in the same manner as in dairy #3. In the six weeks prior to treatment the average of the weekly indices was 24.9 houseflies while in the 18 weeks subsequent to treatment on May 23rd the average of the weekly indices was 5.0 houseflies. At all times in both dairies the weekly index did not rise above the figure of 10 flies which had been arbitrarily selected as the maximum for good control in dairies.

Larvae

The use of various insecticides against the larvae of houseflies in cow manure has been investigated in limited scale operations.

Freshly dropped manure was obtained prior to the time flies had an opportunity to deposit eggs in it and was placed in wooden boxes 18"x18"x4". It was then brought to the laboratory grounds and placed under screened cages. On the following day 3000 (determined by weight) newly hatched larvae were scattered in each box. In approximately 5 days, when the larvae were full grown, the surface of the manure was treated with various spray materials. The manure was then held in the screened cages until adult emergence began and counts were made daily of the number of adult flies in each cage.

Table 10 shows the insecticides tested, the percent of active ingredient in the emulsion, and the dosages required to produce 90 percent or better control in comparison to untreated checks.

Dusts containing 10 percent hexachlorocylohexane (DuPont) or 10 percent Hercules Toxicant "3956" were tested in forty shallow pit and deep pit privies with occasionally a surface or filled pit among them. Since no perceptible difference in the effective results of laboratory tests at 600 mg. and 1200 mg. per square foot were obtained for these two agents, it was decided to apply a minimum of 900 mg. per square foot in the field trials. Since the surfaces being treated in the field

Table 10. Dosages of various formulae necessary to produce 90 percent control of housefly larvae.

Insecticide	Dosage Mg./sq. ft.
5% DDT Dust	over 800
1% "1068"-xylene emulsion	less than 200
1/2% "3956"-xylene emulsion	100
1% "3956"-xylene	200
1% "666"-xylene	over 400
1% Tetrachlorethane--Xylene Emulsion	over 400
1% DDD-xylene Emulsion	over 400
20% O.D.B. emulsion*	65,000
10% O.D.B. emulsion*	19,500

*Applied as 25, 50 and 100 cc of Tech. ODB in the 20% emulsion and as 15, 25 and 35 cc of Tech. ODB in the 10 percent emulsion.

were rarely flat, this figure served only as a guide, for in practice, 2 to 3 1/2 oz. of 10 percent dust were applied per privy, with variation for the conditions found in each case.

The dust was applied with a Cyanogas foot duster which gave an excellent dust fog and assured good coverage. A dust respirator was worn for protection, but no other precautions were used. The treatment procedure was simply that of blowing the requisite amount of dust into the pit, using a four foot hose on the duster to direct the dust about as needed. The proper amount of dust was determined by using a graduated pint mason jar as the dust reservoir. It was unnecessary to cover the privy holes during the dusting.

Inspection of the privies was not by sampling, but by studying the pit contents with a flashlight and noting the activity of the fly larvae on the surface. Almost without exception, all untreated privies were very heavily infested with stratiomyid and muscoid larvae.

The results of dusting a group of privies are shown in table 11, in which the degree of fly infestation is graded by letter.

Results of the field trials of "666" and "3956" showed that the latter is the better insecticide, although both are effective. At the end of two weeks almost all privies treated with the 10 percent "3956" dust were still under control while only a few of those treated with "666" were under control. After 37 to 40 days, the treated privies showed little effects of treatment.

On the basis of these preliminary field tests, it is believed that 10 percent Hercules "3956" dust applied at the rate of 2 1/2 to 3 1/2 ounces per privy pit, will control fly larvae for two weeks or longer.

Table 11. Effect of larviciding on fly infestations in pit privies (All heavily infested before treatment):

a. With 10 percent "666" dust at 2-3 oz. per privy:

Time after treatment in days	No. privies by degree* of control						Total No. Observed
	A	B	C	D	E	F	
3 - 4	3		4	4	5	1	17
14 - 16	1		2	3	2	1	9
21					2	7	9
37 - 40		1		1	1	5	8

b. With 10 percent "3956" dust at 2-3 1/2 oz. per privy:

Time after treatment in days	No. privies by degree* of control						Total No. Observed
	A	B	C	D	E	F	
3 - 4	9		1	3	5	1	19
14 - 16	11	3		1		1	16
37 - 40		1	1	3	3	4	12

*A = Complete control (no larvae observed).
B = Only a very few larvae observed.
C = Several larvae observed.
D = Larvae locally common or lightly distributed.
E = Larvae generally common or in heavy numbers locally.
F = No control (larvae present in large numbers).

There are indications that "3956" dust may reduce bacterial activity in the privy contents. This point should be investigated further before the insecticide is given widespread use.

AIRPLANE TREATMENT OF THE SAVANNAH WILDLIFE REFUGE

H. Stierli, W. R. Schmitz

Weekly treatment of the four Savannah Wildlife Refuge plots for studies on the effects of DDT on aquatic and terrestial forms of life was completed on September 4, 1946. Although simultaneous aerosol and spray applications were conducted from May 1 through July 16, 1946, the last six weekly treatments were in accordance with the following procedure;- treat pools 3 and 3A with aerosol starting at dawn, return to airport for metering and refilling of solution tanks, and then spray pools 2 and 6.

Table 12 presents a summary of the operational and meteorological data obtained for aerosol and spray applications from July 2 through the final treatments on September 4, 1946. Sunrise time, start and finish time, and net treatment time are given for each application. Average meteorological conditions during treatment including air temperature, temperature differential, wind velocity and wind direction are presented. The output dosages are also given in table 12.

Pools 3 and 3A each received 15 aerosol applications for a total output dosage of 1.60 pounds DDT per acre. Pool 2 was sprayed 16 times for a total output dosage of 1.54 pounds DDT per acre, whereas pool 6 received 17 spray treatments for a total output dosage of 1.64 pounds DDT per acre. The average output dosages per treatment were therefore 0.107 pounds DDT per acre for the aerosol pools and 0.093 pounds DDT per acre for the spray pools.

All techniques employed in evaluating the dispersal of DDT by the

Table 12. Summary of operational and meterological data for airplane aerosol and spray applications at the Savannah Wildlife Refuge from July 2 through September 4, 1946.

Date	Type Treat-ment	TIME				Average Meteorological Conditions				Output Dosage lbs. DDT/acre
		Sunrise (A.M.)	Start (A.M.)	Finish (A.M.)	Treatment (MIN.)	T_6 (^oF)	T_6-T_1	V_6 (mph)	Wind Directions	
7/2	aerosol	5:20	5:09	5:55	46	72.4	0.0	1.0	SE	0.09
	spray	5:20	5:10	6:02	52	72.4	0.0	1.0	SE	0.10
7/9	aerosol	5:24	5:10	5:58	48	73.0	0.0	1.7	WSW	0.09
	spray	5:24	5:20	6:14	54	73.0	0.0	1.7	WSW	0.10
7/16	aerosol	5:27	5:09	6:00	51	74.6	0.2	1.9	W	0.10
	spray	5:27	5:17	6:12	55	74.6	0.2	1.9	W	0.10
7/23	aerosol	5:31	5:17	6:10	53	72.2	0.0	3.0	SW	0.12
	spray	5:31	6:40	7:40	60	75.0	-1.0	4.0	SW	0.09
7/30	Rainy and windy all week. No treatment.									
8/6	aerosol	5:40	5:38	6:22	44	70.9	0.4	1.5	SW	0.11
	spray	5:40	6:56	8:03	67	74.5	-0.5	2.9	WSW	0.10
8/13	aerosol	5:44	5:28	6:13	45	74.0	0.0	3.4	NNE	0.10
	spray	5:44	6:42	7:42	60	77.9	-0.4	3.6	NNE	0.08
8/20	aerosol	5:49	5:38	6:22	44	73.1	0.3	2.2	S	0.10
	spray	5:49	7:00	8:09	69	77.7	-0.5	2.7	SSW	0.10
8/27	aerosol	5:54	5:41	6:29	48	68.3	-0.1	3.8	NNE	0.11
	spray	5:54	7:19	8:28	69	75.7	-2.1	3.8	NNE	0.10
9/4	aerosol	5:59	5:53	6:41	48	67.5	0.2	3.6	NNE	0.10
	spray	5:59	7:16	8:26	70	72.2	-2.6	5.9	NE	0.10

Notations: T_1---Temperature (^oF) 1 foot above ground level.
T_6---Temperature (^oF) 6 feet above ground level.
V_6---Wind Velocity 6 feet above ground level.

PT-17 airplane were previously reported in "Summary of Activities No. 6". No attempt was made to sample the deposited DDT on some of the treatments. The recovered dosage for each pond and dike is reported in tables 13a and 13b as the average of the twelve stations on the ponds and the average of six stations on the dikes. The standard error of the mean for each pond and dike is also given. The mean for the entire season is based on all sampled treatments from May 1 to September 4. With the spray type dispersal of DDT, the recovered dosages have ranged from a low of 37 percent to a high of 96 percent recovery on the ponds, and from 13 percent to 88 percent recovery on the dike. With the thermal aerosol type dispersal of DDT, the recovered dosages have ranged from a low of 5 percent to a high of 25 percent recovery on the ponds, and from 2 percent to 18 percent recovery on the dike.

On Pool #6, which received the spray application, and on Pool #3A, which received the thermal aerosol application of DDT, four special stations were selected close to the regular stations. These four special stations on each pool were approximately 150 to 200 feet apart and each held 3 glass panels placed side by side. An analysis of variance was made on the data and the results obtained showed a very significant increase in variation between the stations compared to the variation within a station for both the spray and thermal aerosol type application. The variance between stations was considerably less for aerosols than it was for sprays indicating a more uniform distribution though a much lighter deposit.

Table 13a. Recovered dosage obtained in thermal aerosol application of 20 percent DDT in Velsicol NR-70 by PT-17 airplane at the Savannah Wildlife Refuge.

DATE	Dosage Applied lb.DDT/acre	POOL #3A			POOL #3			Dike Along POOL #3 - #3A		
		Dosage (1) Recovered lb.DDT/acre	Standard Error lb.DDT/acre	Percent Recovery	Dosage (1) Recovered lb.DDT/acre	Standard Error lb.DDT/acre	Percent Recovery	Dosage (2) Recovered lbDDT/acre	Standard Error lbDDT/acre	Percent Recovery
July 2,1946	0.09	0.008	±0.0010	9%	0.008	±0.005	9%	0.003	±0.0006	3%
July 9,1946	0.09	0.010	±0.0005	11%	0.012	±0.0014	13%	0.002	±0.0002	2%
Aug.13,1946	0.10	0.010	±0.0017	10%	0.012	±0.0012	12%	---	---	--
Aug.27.1946	0.11	0.005	±0.0012	5%	0.016	±0.0027	15%	0.005	±0.0008	5%
Mean for entire season	0.107	0.0108	±0.0004	10%	0.0126	±0.0010	12%	0.0083	±0.0015	8%

Table 13b. Recovered dosage obtained in spray application of 20 percent DDT in Velsicol NR-70 by PT-17 airplane at the Savannah Wildlife Refuge.

DATE	Dosage Applied lbDDT/acre	POOL #6			POOL #2			Dike along POOL #6		
		Dosage (1) Recovered lb.DDT/acre	Standard Error lb.DDT/acre	Percent Recovery	Dosage (1) Recovered lb.DDT/acre	Standard Error lbDDT/acre	Percent Recovery	Dosage (2) Recovered lb.DDT/acre	Standard Error lb.DDT/acre	Percent Recovery
July 2,1946	0.10	0.096	±0.014	96%	0.078	±0.0010	78%	0.088	±0.071	88%
July 9,1946	0.10	0.068	±0.021	68%	0.093	±0.031	93%	0.050	±0.015	50%
Aug.13,1946	0.08	0.037	±0.008	46%	---	---	--	0.044	±0.013	55%
Aug.20,1946	0.10	---	---	--	0.065	±0.017	65%	---	---	--
Aug.27,1946	0.10	0.060	±0.010	60%	---	---	--	0.024	±0.006	24%
Mean for entire season	0.093	0.0512	±0.0038	55%	0.0703	±0.0059	76%	0.0455	±0.0212	49%

Notes:
1. Average of 12 stations.
2. Average of 6 stations.
3. All dosage calculations are based on quantitative chemical analysis of DDT.

EFFECTS OF DDT MOSQUITO LARVICIDING ON WILDLIFE

C. M. Tarzwell, A. B. Erickson[5], E. L. Bishop[6]

Airplane Applications

Experimental studies at the Savannah River Wildlife Refuge on the effects on wildlife of the routine application of DDT larvicides by airplane were continued throughout the third quarter. A total of 815 acres were treated weekly at the rate of 0.1 pound of DDT per acre. All treatments were with a 20 percent solution of DDT in Velsicol NR-70. This material was applied as a thermal or exhaust generated aerosol to two of the ponds and as a spray to the remaining two ponds. The last routine treatment was applied September 4. The sprayed ponds received a total of 17 and 16 treatments respectively while the two aerosol ponds received 15 treatments each.

Fish

Observations conducted throughout the period of treatment indicated a small and probably insignificant kill of fish due to the treatments. Early in the season, before aquatic vegetation became abundant, there were some fish kills probably due to the concentration of the spray materials by wind action. Later in the season very little kill was noted. Since treatment has been discontinued, fish population studies have been made in all of the ponds. While the data from these studies have not been

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5/ Resigned September 13, 1946

6/ Resigned August 31, 1946

analyzed as yet, gross observations at the time of the poisoning indicate little or no direct harm to the fish population. Further study next season would be desirable to detect any indirect effects, such as might occur from a reduction of the food supply.

Plankton

Plankton studies were discontinued in August. The results of these studies may be summarized as follows:

1. The effect on plankton organisms of the routine use of DDT at 0.1 or 0.05 pounds per acre, is so slight in comparison with the larger variations due to climatic and other ecological factors as to be relatively unimportant when the population is considered as a whole.

2. The plankton population as a whole approaches a constant, i.e., the number of plankton organisms supported by a given volume of water remained approximately the same throughout the summer months in treated and check areas.

3. No drastic killing of any specific organisms occurred from DDT treatment during the course of the experiments. Even though a few forms did show a slight reduction in number in the treated ponds over the controls, in no instance were they wiped out or reduced to any marked degree.

4. It appears that the use of DDT as a mosquito larvicide will be restricted more by its potential dangers to the fish than by any harmful effects on the plankton organisms as a group.

Birds and Mammals

Studies of the effects of routine DDT larviciding on birds and mammals were begun in March and discontinued early in September. Extensive weekly observations and counts of all birds and the singing males were employed in the evaluation of the effects of routine DDT larviciding on the bird population. These studies were made over extensive areas of treated and check dykes and islands. No differences were noted in the sprayed and aerosoled areas. The numbers of birds observed in all areas were quite similar. After May 1, there was an increase in the number of singing males but this change was probably caused by the influx of late migrants. The spraying had no apparent effect on the males that had been singing in March, April and May, for their singing continued into July and August. The slight changes that occurred in the distribution and numbers of singing males in sprayed and unsprayed areas during the summer were similar and could not have been caused by the DDT. Further, their was no noted reduction of the bird population in the treated areas and the weekly treatment with 0.1 pound of DDT per acre appeared to have no effect on the birds.

Trapping and tagging of rodents, chiefly cotton rats, was the chief method used for the determination of the effects of routine DDT larviciding on mammals. Fifty to 100 traps were used routinely in this work. Captured animals were marked with ear tags for identification if captured again. In the check areas 21 percent of the rats were retaken after tagging, while in the treated areas 25 percent were retaken. These returns indicate that the activity of the rats and the rate of mortality were about the same in both areas. The numbers of rats retrapped in each area the week of tagging, and in subsequent weeks, are comparable. Since the numbers of immature and adult rats taken in each area were comparable it would appear that the DDT had no effect on the reproduction potential. In short, DDT apparently had no effect on the rodent population of the sprayed areas.

Daily sight observations were made on rabbits in the check and treated areas throughout the period of treatment. These observations indicated no adverse effect due to the treatments.

Insects

Paired light trap collections were made before and after treatment in each of the areas throughout the season. Although the data has not been summarized it is apparent from gross observation of the catch that insects were not exterminated in treated areas. Certain groups of insects however, appeared to be more abundant in the check areas. Gross observations after treatment indicated a considerable mortality of certain insects. Surface Coleoptera such as Dytiscids, Gyrinids and Hydrophilids and the aquatic Hemipters, especially Corixids, were killed in considerable numbers. Many adults of aquatic Diptera were also found dead on the water surface. Although the nymphs of dragon and damsel flies are resistant to DDT, the adults are quite susceptible to it and large numbers of them were killed. Further study next season is indicated to determine the long time effect of treatment on these important aquatic insects.

Five hives of honey bees kept in the treated area survived 17 routine treatments. There was no indication of serious harm to the colonies which collected honey throughout the season. Local bee keepers are not now adverse to airplane larviciding in the vicinity of their hives.

Studies of Other Larvicides

Studies of the effects on fish of the routine larvicidal use of DDT, DDD, "3956" and "1068" in ponds 3 to 10 feet deep were undertaken in July. Each of these materials were applied at the rates of 0.1, 0.05 and 0.025 pound per acre in similar ponds, with the exception of "3956" which was applied at the rate of 0.2, 0.1 and 0.05 lb. per acre. Check ponds were observed for each of these three series of treatments. Three groups of ponds were studied so that all treatments at a given dosage were in similar ponds. All materials were dissolved in fuel oil and applied at the rate of a gallon of solution per acre by means of a hand sprayer and atomizing nozzle.

Examinations were made 24 to 48 hours after each treatment. Nine routine treatments have now been made. Of these materials "3956" is by far the most toxic. The first treatment at 0.2 and 0.1 pound per acre killed fish in ponds 10 and 5 feet deep respectively. After the third treatment all fish appeared to be killed. At the rate of 0.05 lb. per acre the first fish kill occurred after the fifth treatment.

No kill has yet been noted in the ponds treated with DDD or "1068". Three dead fish have been found in the pond treated with DDT at the rate of 0.05 lb. per acre but no kill has been noted in the pond receiving 0.1 lb. per acre. The latter has considerable vegetation and may explain the difference if the kill in the first pond was due to the DDT. At the conclusion of the fourteenth treatment all the ponds will be poisoned so the effects of the treatments on the fish population can be determined more accurately.

ANOPHELINE LARVICIDE STUDIES

F. F. Ferguson7/, J. G. Gillespie

Comparative Swath Widths

Preliminary tests were conducted to determine the effective swath width obtained by dusting with paris green as compared with that obtained by use of the recommended DDT-oil mist spray. The technique employed was to apply one material at the usual rate along several yards of the windward bank of a uniformly infested pond. After leaving a suitable buffer area the other treatment was applied at the usual rate along several more yards of the same bank. By carefully selecting uniform ponds with uniformly heavy infestation of anopheline larvae and by having both materials applied by the same operator with as little delay as possible, a rather valid comparison of effective swath width could be obtained. The width was evaluated by dipping for larvae in parallel lines perpendicular to the bank and measuring the distance from the bank to the point where larvae were first found two or more per dip or in two out of three dips.

A summary of preliminary results in five such paired tests is presented in table 14. The rate of application in all these tests were designed to apply 0.5 lb. paris green or 0.05 lb. DDT per acre using a 30 ft. swath width. It appears that a dust will carry appreciably farther than an oil mist under the same conditions though it is doubtful if this will offset the other advantages of the DDT-oil mist spray.

7/ Resigned August 31, 1946

Table 14. Comparative effective swath widths of paris green dust and DDT-oil mist spray.

Date	Wind Velocity m. p. h.	Effective swath width in feet	
		P. G. Dust	DDT-Oil Mist
9/11	1	150	60
9/11	3-4	110	66
9/19	4	60	30
9/25	4	75	45
9/12	5	60	30
Mean		91	46

Airplane Application of DDT

In an effort to determine the relative values of exhaust thermal aerosols and airplane sprays for application of DDT as a larvicide, critical time - morbidity studies were undertaken. Two similar ponds heavily infested with anopheline larvae and suitable for airplane treatment were selected. The pretreatment infestation was determined by dipping and the posttreatment populations were determined by the same technique, 15 min., 30 min., 1, 2, 3, 4, 6, 8, 24, and 72 hours after treatment. The results are shown in figure 1.

The thermal aerosol is faster acting than is the spray, having inactivated an appreciable portion of the larvae during the first fifteen minutes, whereas no appreciable inactivation was detected in less than one hour as a result of the spray.

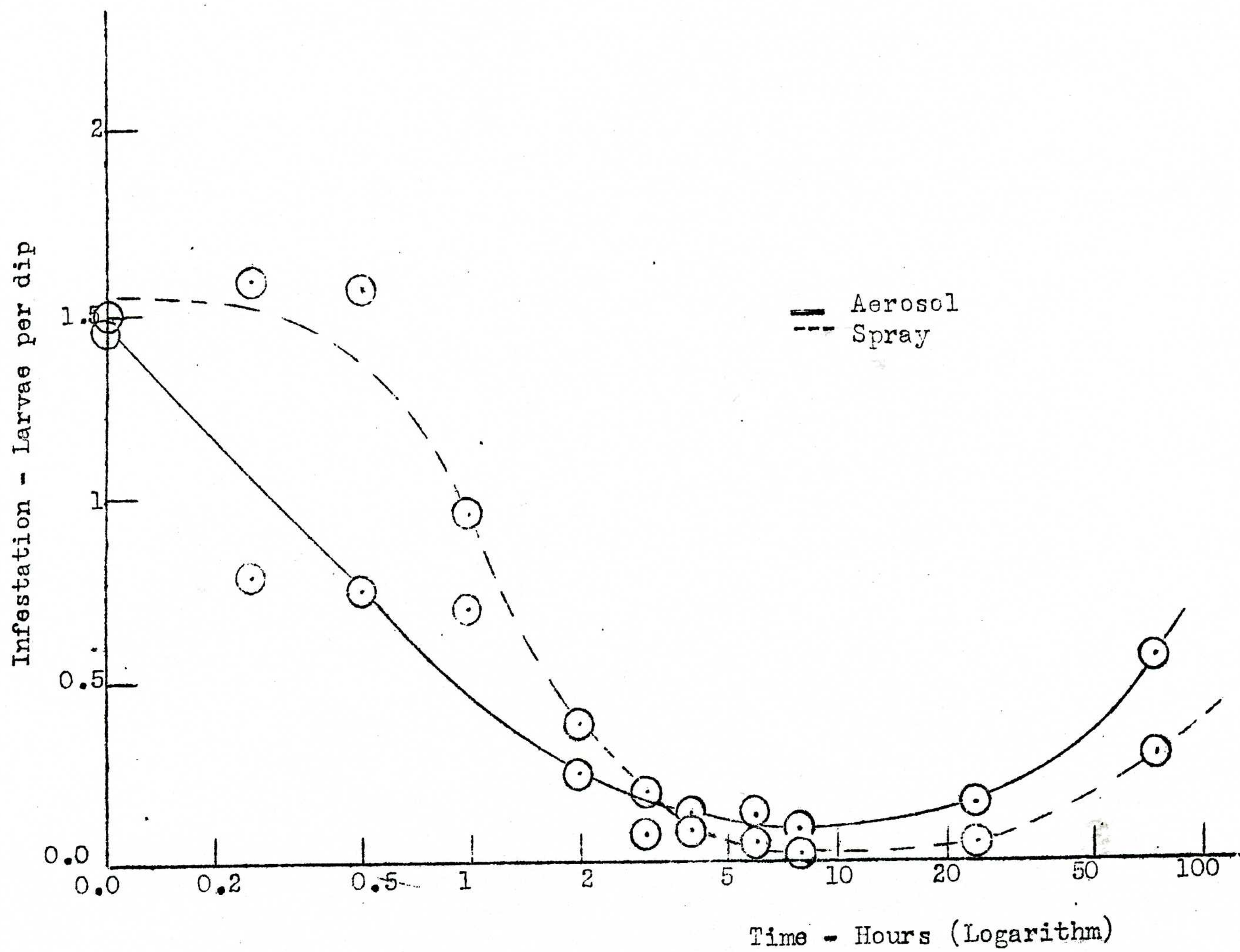

Fig. 1 Time - morbidity data for airplane application of DDT as a larvicide spray or thermal aerosol.

On the other hand the spray was more effective after 8 to 24 hours, reducing the population to 0.05 larvae per dip or less as compared with 0.10 to 0.15 larvae per dip as a result of the aerosol treatment.

These results are not entirely unexpected since the finer particle size of the aerosol might well account for its faster action whereas the spray, due to its larger particle size, deposited a greater amount of DDT on the surface and so should produce a greater mortality after 24 hours.

Hexachlorocyclohexane

Hexachlorocyclohexane has given excellent results as an anopheline larvicide when applied as a dust at 0.05 lb. of gamma isomer per acre. In a further effort to employ the solubility of this material in water as a method of lengthening the period between treatments, porous bags containing an excess of the material were suspended in ponds at the time that the ponds were being dusted with the same material. Again this technique failed to extend the residual effectiveness of the dust.

Other materials

In field tests Velsicol "1068" has produced control roughly equivalent to that produced by equivalent dosages of DDT. However on an equivalent cost basis it cannot compare with DDT.

Hercules "Toxicant 3956" has produced adequate control at 0.05 or 0.1 lb. per acre but at dosages of 0.05 or less the results have been very erratic. Its toxicity to fish would preclude its use as a general larvicide.

RODENT AND ECTOPARASITE CONTROL INVESTIGATIONS

P. A. Woke, H. P. Nicholson, J. T. Grimsley[8], T. B. Gaines

Control of Rat Ectoparasites with 5 Percent DDT

A series of investigations was initiated in July, 1946 in Columbia, S. C. to determine the value of 5 percent DDT in pyrophyllite for the control of ectoparasites of rats, especially rat fleas.

The methods of treatment employed were those now commonly in use by the U. S. Public Health Service in its typhus control programs in the Southern States, i.e. the dusting of rat burrows, harborage areas and runways.

Equipment employed consisted of the _Cyanogas_ foot pump duster and two types of sifter dusters. The _Cyanogas_ duster was fitted with a 5 pound capacity side chamber and was used in dusting rat burrows and enclosed harborage areas. The sifter dusters were a rectangular can with a capacity of about 4 pounds used in dusting exposed runs, and a small cylindrical can of 3/4 lb. capacity mounted on a three foot stick to use in dusting runs difficult to reach by other means. This equipment has been more fully described in earlier reports.

Major emphasis was placed on the use of the _Cyanogas_ foot pump duster in an attempt to dust flea breeding areas directly, if possible, rather than depending upon achieving control primarily by dusting runways from

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8/ Transferred August 3, 1946.

which rats will contact the dust and carry it back to burrows, nests and harborages.

Seventeen business establishments were chosen for treatment because they were moderately to heavily infested by rats. The species of rat encountered was Rattus norvegicus. The establishments included six retail grocery stores, six cafes and one each of the following: grocery warehouse, wholesale produce store, drug store, paint store, and feed store. Dust was applied ranging in amount from 1 3/4 lbs. to 14 1/2 lbs. per establishment, depending upon size and the degree of infestation. The average was 5.2 lbs. per establishment. In addition eighteen establishments of similar type were selected for use as checks.

The results obtained with 5 percent DDT in individual establishments are shown in table 15. A simple mean, called an index, is used to express the rate of ectoparasite infestation per rat since the numbers of rats taken were relatively small. It should be noted that the reduction in infestation of the oriental rat flea, Xenopsylla cheopis, and in all species of fleas[9] was consistant in all seventeen of the premises treated.

A summary of rat ectoparasite populations found in untreated establishments and used as check data is presented in table 16.

Table 17a indicates the degree and duration of control achieved against X. cheopis and against all species of fleas collected from rats caught in

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9/ Xenopsylla cheopis (Rothschild), Nosopsyllus fasciatus (Bosc), Leptopsylla segnis (Schonherr), Echidnophaga gallinacea (Westwood), and Ctenocephalides felis (Bouche).

Table 15. Results of Dusting with 5 percent DDT for the Control of Rat Ectoparasites.

Establishment	Days After Treatment	Live Rats Trapped	Ectoparasites: X. cheopis No.	X. cheopis Index	All Fleas No.	All Fleas Index	Mites No.	Mites Index	Lice No.	Lice Index	All Parasites No.	All Parasites Index
C-1 Grocery Store	Pre-treat	3	117	39.0	119	39.7	3	1.0	0	0.0	122	40.7
	6-7	5	8	1.6	8	1.6	1	0.2	0	0.0	9	1.8
	47-50	13	5	0.4	7	0.5	0	0.0	33	2.5	40	3.1
C-2 Grocery Warehouse	Pre-treat	8	658	82.3	749	93.6	61	7.6	10	1.3	820	102.5
	6-7	3	2	0.7	2	0.7	0	0.0	0	0.0	2	0.7
	47-49	3	1	0.3	1	0.3	1	0.3	5	1.7	7	2.3
C-3 Drug Store	Pre-treat	3	69	23.0	70	23.3	20	6.7	2	0.7	92	30.7
	6-7	2	1	0.5	1	0.5	3	1.5	0	0.0	2	2.0
	48-49	3	0	0.0	0	0.0	16	5.3	27	9.0	43	14.3
C-4 Paint Store	Pre-treat	3	65	21.7	65	21.7	110	36.7	0	0.0	175	58.3
	6-7	3	0	0.0	0	0.0	4	1.3	0	0.0	4	1.3
	50	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
C-5 Cafe	Pre-treat	2	108	54.0	108	54.0	136	68.0	0	0.0	244	122.0
	6	2	0	0.0	0	0.0	2	1.0	0	0.0	2	1.0
	48	1	1	1.0	1	1.0	26	26.0	0	0.0	27	27.0
C-6 Grocery Store	Pre-treat	1	19	19.0	128	128.0	1	1.0	2	2.0	131	131.0
	7	2	0	0.0	1	0.5	0	0.0	0	0.0	1	0.5
	50	1	0	0.0	4	4.0	0	0.0	0	0.0	4	4.0
C-7 Cafe	Pre-treat	6	575	95.8	594	99.0	1	0.1	0	0.0	595	99.1
	6	2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	48-49	8	6	0.7	8	1.0	17	2.1	0	0.0	25	3.1
C-8 Wholesale Produce	Pre-Treat	4	56	14.0	70	17.5	171	42.8	4	1.0	245	61.3
	48	1	2	2.0	69	69.0	5	5.0	3	3.0	77	77.0
C-9 Grocery	Pre-Treat	5	181	36.2	181	36.2	0	0.0	1	0.2	182	36.5
	46-47	16	2	0.1	2	0.1	0	0.0	0	0.0	2	0.1
C-10 Cafe	Pre-treat	7	115	16.4	115	16.4	19	2.7	0	0.0	134	19.1
	6	5	16	3.2	16	3.2	2	0.4	0	0.0	18	3.6
	48-50	5	30	6.0	30	6.0	134	26.8	0	0.0	164	32.8
C-11 Grocery Store	Pre-Treat	6	216	36.0	248	41.3	36	6.0	4	0.7	288	48.0
	6-8	4	0	0.0	4	1.0	5	1.3	0	0.0	9	2.3
	48-49	10	1	0.1	1	0.1	2	0.2	12	1.2	15	1.5
C-12 Cafe	Pre-treat	1	14	14.0	14	14.0	0	0.0	3	3.0	17	17.0
	7	1	1	1.0	1	1.0	1	1.0	3	3.0	5	5.0
	48	3	17	5.7	17	5.7	0	0.0	11	3.7	28	9.3

Table 15. Results of dusting with 5 percent DDT for the control of Rat Ectoparasites - - - - (Continued)

Estab-lish-ment	Days After Treatment	Live Rats Trapped	Ectoparasites									
			X. cheopis		All Fleas		Mites		Lice		All Parasites	
			No.	Index	No.	Index	No.	Index	No.	Index	No.	Index
C-13 Cafe	Pre-treat	7	74	10.6	74	10.6	168	24.0	6	0.9	248	35.4
	6-7	4	0	0.0	0	0.0	280	70.0	4	1.0	284	71.0
	48-49	6	2	0.3	2	0.3	401	66.8	1	0.2	404	67.3
C-14 Feed Store	Pre-treat	9	169	18.8	169	18.8	126	14.0	6	0.7	301	33.4
	6-7	12	*6	0.5	6	0.5	30	2.5	0	0.0	36	3.0
	48-49	26	6	0.2	6	0.2	74	2.8	31	1.2	111	4.3
C-15 Grocery Store	Pre-treat	4	62	15.5	74	18.5	4	1.0	0	0.0	78	19.5
	6	1	0	0.0	1	1.0	0	0.0	0	0.0	1	1.0
	48-49	2	0	0.0	0	0.0	0	0.0	37	18.5	37	18.5
C-16 Grocery Store	Pre-treat	3	82	27.3	82	27.3	1	0.3	3	1.0	86	28.7
	6	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	47-48	9	22	2.4	30	3.3	6	0.7	**1530±	170.0±	1566±	174.0±
C-17 Cafe	Pre-treat	5	89	17.8	89	17.8	8	1.6	0	0.0	97	19.4
	6	5	4	0.8	4	0.8	0	0.0	0	0.0	4	0.8
	47-48	2	1	0.5	1	0.5	0	0.0	0	0.0	1	0.5
*Totals	Pre-treat	77	2669	34.7	2949	38.3	865	11.2	41	0.5	3855	50.1
	6-8	52	37	0.7	44	0.9	328	6.3	7	0.1	379	7.3
	47-50	110	96	0.9	179	1.6	682	6.2	1690	15.4	2551	23.2
***Totals	6-8	53	108	2.0	117	2.2	329	6.2	7	0.1	453	8.6

* One aberrant rat with 71 X. cheopis omitted from consideration.

** One rat with 1500 lice.

*** Totals including the aberrant rat in C-14.

Table 16. Summary of rat ectoparasite populations in untreated establishments.

Total Establishments	Trapping Dates	Mean Trapping Date	Live Rats Trapped	Ectoparasites									
				X. cheopis		All Fleas		Mites		Lice		All Ectoparasites	
				No.	Index	No.	Index	No.	Index	No.	Index	No.	Index
17	July 30-Aug. 3, 1946	July 31	77	2669	34.7	2949	38.3	865	11.2	41	0.5	3855	50.1
18	Sept. 17-27	Sept. 24	*53	1234	23.3	1410	26.6	3585	67.6	151	2.8	5146	97.1

*One aberrant rat with 354 X. cheopis, 2 mites and 2 lice omitted from consideration.

the test area. Two aberrant cases are not included in this table, but are discussed below.

It will be noted in table 17a that a week after the dust was applied X. cheopis had been reduced in number by 98 percent and all fleas to only a slightly lesser degree. One and a half months following dusting control still remained highly effective.

Table 17b shows the degree and duration of control achieved if the two aberrant cases mentioned above are included. In one case a single rat caught from a treated feed store 6-7 days following dusting bore 71 X. cheopis. This rat was one of 13 caught there during that trapping period. The other 12 rats bore a total of only 6 fleas. The total number of X. cheopis collected from the remaining 52 rats taken during the same period was only 3/4 the total taken from this one rat. This aberrant rat very probably was an untreated individual caught shortly after entering the feed store.

The second aberrant case was a rat taken from a check establishment during the 47-50 day trapping period which bore 354 X. cheopis. Of the other check rats taken during that period, the maximum number of X. cheopis combed from a single rat was 91. Five other rats taken from the same extablishment as the aberrant one had 15, 18, 23, 69, and 70 X. cheopis.

No claim is made at this time for controlling rat mites or lice. Mite and louse figures varied between wide extremes among the rats examined. Although some reduction in the total mite population may have resulted at one week following dusting, further study is necessary to determine if this reduction is real or only apparent.

This study is being continued to determine the duration of practical control of rat fleas. Initial control under these conditions as herein reported appears promising but further information on the duration of control is essential before a dust containing less than 10 percent DDT can be recommended.

Table 17a. Degree of control and duration of control achieved against rat fleas by use of 5 percent DDT dust, omitting aberrant cases.

Days after Treatment (Duration of control)	Indices in un-treated establishments		Mean Trapping Date	Indices in Treated Establishments		Mean Trapping Date	Degree of Control	
	X. cheopis	All Fleas		X. cheopis	All Fleas		X. cheopis	All Fleas
6 - 8	34.7	38.3	July 31	0.7*	0.9	Aug. 8	98.0%	97.7%
47 - 50	23.3**	26.6	Sept.24	0.9	1.6	Sept.19	96.1%	94.0%

* One aberrant rat with 71 X. cheopis omitted from consideration, but counted in the table 17b.

** One aberrant rat with 354 X. cheopis omitted from consideration, but counted in the table 17b.

Table 17b. Including two aberrant cases.

6 - 8	34.7	38.3	July 31	2.0	2.2	Aug. 8	94.2%	94.3%
47 - 50	29.4	32.7	Sept.24	0.9	1.6	Sept.19	96.9%	95.1%

Date of Treatment 8/1 - 3/46

Rodenticide Investigations

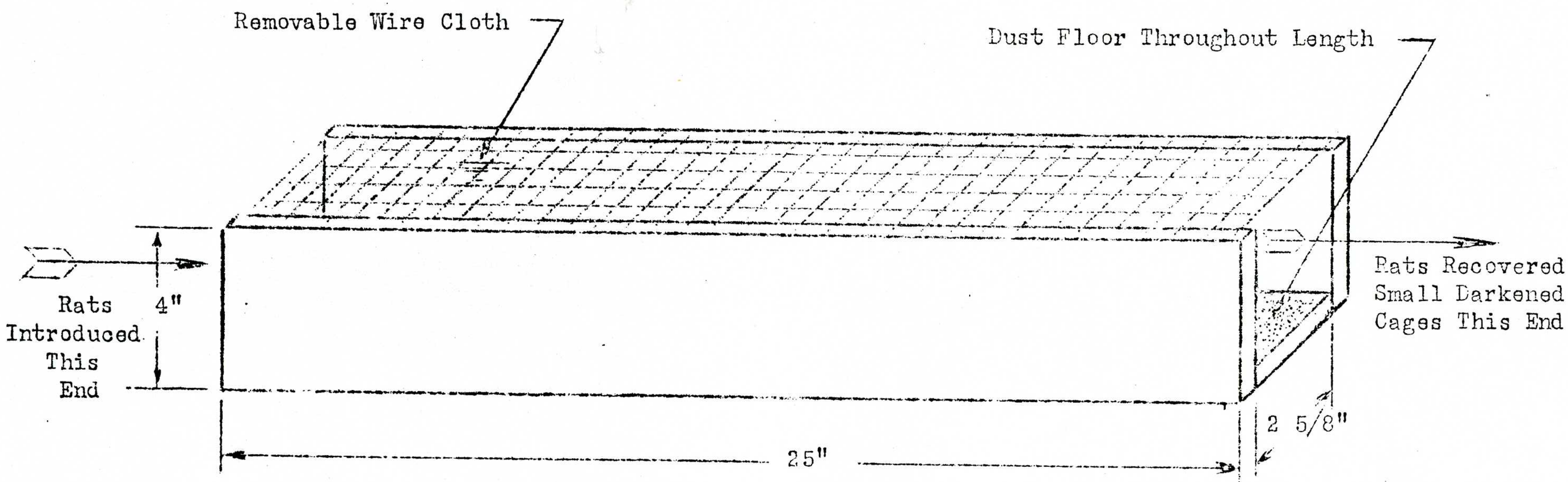
Antu - DDT Investigations

Investigations were undertaken to determine, under controlled laboratory conditions, the mortality rate among Norway rats exposed to a 20 percent ANTU-10 percent DDT dust mixture. The data obtained provides auxiliary information on the Norway rat mortality likely to occur as a result of field use of the mixture.

One hundred adult Norway rats, 90 percent females, and 96 immature rats were exposed to the dust by passage through an artificial rat run twenty-five inches long by three inches wide (see fig. 2). From 10 to 15 grams of 20 percent ANTU-10 percent DDT dust had been sprinkled over the floor of this run prior to the passage of each rat.

The rats were introduced at one end of the run and recovered in a box at the other end. In each case contact in the run was limited to the time required for the rat to pass from one box to the other. The rats were immediately placed in observation cages containing a source of water but no food. The floors of the cages were of wire mesh so that dust falling from the feet, tail and other parts of the body was removed from possibility of further contact. Food was offered on the following day to those rats remaining alive.

All rats used in the tests were caught uninjured from the city dump and were held four days or longer prior to exposure to insure having normally healthy rats for testing. Killing time varied from a minimum of 3 hours to a maximum of 71 hours. Over 2/3 of the rats succumbing died less than 24 hours after the initial contact.



NOTE:
Material 1/2" Plywood

Fig. 2 Runway For Laboratory ANTU Poisoning Tests

The immature rats exhibited considerably more resistance than did the adults. Mortality among this group of 96 rats was 30 percent. Killing time varied from 12 to 117 hours. As was the case with the adults, about 2/3 of the mortality occurred within the first 24 hours.

Of the first 185 rats caught, 100 were adults, the remainder immature. Mortality among this mixed age group was 61 percent.

Further investigations are in progress with dusts containing other concentrations of ANTU.

Investigations with "Rattengift"

A rodenticide of German origin, the sodium salt of p-dimenthylamino-benezenediazo sulfonic acid, commonly called "Rattengift", was submitted by the U. S. Fish and Wildlife Service for testing. The results of very preliminary tests in the laboratory to determine the proper proportion of poison to bait are presented in table 18. All rats utilized were wild caught *R. norvegicus*, and ground fresh fish was used as bait.

"Rattengift" in concentrations of 1/8, 1/4, 1/2 and 3/4 percent in fresh fish was progressively more effective but also progressively less acceptable to rats. In concentrations of 1 percent or more it was found to be very poorly accepted although high mortality resulted in most cases. Check baits containing no poison were in each case entirely consumed. Death of the poisoned rats occurred over a period of from less than 18 hours to six days, with over half occurring within the first 30 hours and about 3/4 dying within 48 hours.

Table 18. Preliminary results of laboratory tests to determine the proper concentration of "Rattengift" to use in fresh fish bait for poisoning Norway rats.

Concentration of Poison	Age of Rats	Number of Rats	Number Died	Percent Mortality	Acceptance of Baits
4%	Adult Immature Age Unknown	1 1 1	1 1 1	100%	Poor
3%	Adult Age Unknown	2 1	2 1	100%	Poor
2%	Adult Immature Age Unknown	1 2 1	1 0 1	50%	Poor
1%	Adult Immature Age Unknown	1 2 1	1 2 1	100%	Poor
3/4%	Adult Immature	5 3	5 2	87%	Fair (1 bait poorly, 2 partially& 2 well)
1/2%	Adult Immature	4 2	3 2	83%	Fair (2 baits poorly, 2 partially & 2 well)
1/4%	Adult Immature	3 5	3 2	63%	Good
1/8%	Adult Immature	2 2	0 0	0%	Good

Using the information presented above as a guide, field tests were conducted in two business establishments. The first test was made in a large wholesale grocery store which was heavily infested with Norway rats. One percent "Rattengift" in ground fresh fish was used. Of 181 baits distributed, only 31 could be found on the second day following poisoning. Seven of these were discovered cached in one place. Two other baits had been partially eaten. Two dead rats were recovered during the observation period following poisoning. No odors were apparent.

On the eighth day following poisoning a treatment with "1080" solution was made. Only two rats were recovered. The patch test which was used following this phase of the treatment indicated that live rats remained in all parts of the store.

The second test was made in a feed store having a moderate rat infestation, and which was open to almost constant reinfestation from the outside. The fish bait used in this case contained 3/4 percent "Rattengift".

Sixty-seven baits were distributed and allowed to remain for three nights before recovering. Twenty-seven baits were recovered. A week was allowed for the poison to take effect. At the end of this period a total of five rats had been recovered and five separate odors noted indicating a kill of at least ten rats. Some of these rats and odors were found outside the store but in the immediate neighborhood.

On the seventh day of the test a treatment was made with "1080" solution. A total of six rats were recovered and two isolated odors resulted. The patch test was applied and subsequent tracking indicated that a number of live rats still remained.

The presence of live rats after using "Rattengift" does not mean in this case that the treatment failed. In a building of this type repopulation from outside sources may take place immediately.

Rat-proofing Investigations

Work was continued on tests of the rat-resistant qualities of materials which are under consideration for use in ship construction. The ship rat or roof rat, Rattus rattus alexandrinus is used exclusively at present. The equipment and methods are those previously described (Summary of Activities No. 6, Second quarter, 1946) with minor modifications.

In marked contrast to the common construction materials previously tested and reported upon, in which several were penetrated by rats, the materials tested this period were all relatively highly resistant to rat gnawing. None were penetrated, though several were damaged, and with continued exposure, most likely will be penetrated.

The provision of a suitable gnawing edge in certain cases, has aided the rat's gnawing activities. Observations indicate that almost any condition of the test material which enables the rat to set its incisors beyond the surface, may constitute in varying degrees, a gnawing edge. However, the effectiveness with which the rat is able to gnaw depends in large measure on the suitability of the gnawing edge and the composition of the material. The simplest case is that of very soft material which the rat is able to cut into with its incisors, thereby gaining an edge and creating for itself as it gnaws into the material, an increasingly more suitable gnawing edge. A different case is that of harder material, which the rat is unable to cut into with its incisors. In such cases, scratches, gouges, holes of different sizes, cuts, damaged areas or free edges, appear to be essential to give the animal a start. Progress thereafter depends upon the animal's ability to break or tear off portions of the material, rather than to cut or bite the material.

The materials of undisclosed composition listed in table 19 have been attacked in such a degree as to be worthy of note. An 11/16 inch hole bored near the lower edge provided a highly favorable gnawing edge. Exposures were made on sixteen to eighteen nights to as many different rats. Duplicate materials in which a gnawing edge of 1/4" was provided between the

Table 19. Building materials which have been attacked by rats, when provided with an 11/16 inch hole.

Material	Extent of Gnawing
C-5 Marine Board 3/16" thick	Hole not enlarged except for one 1/8 inch chip. Area extending 5/8 inch from edge of hole, gouged with depth increasing sharply to edge of hole.
C-5 Marine Board 1/4" thick	Hole not enlarged. Area extending 1/2 inch from edge of hole, gouged with shallow tooth marks.
C-4 Marine Board 3/16" thick	Hole not enlarged except for one 1/8 inch chip. Area extending 1/2 inch from edge of hole, gouged deeply, soon to penetrate.
C-4 Marine Board 1/8" thick	Hole enlarged 3/16 inch to 5/16 inch. Area extending 1/2 inch from edge of hole, gouged with deep tooth marks, soon to penetrate.

lower edge and the floor of the cage, received little or no damage. All other materials which were set flush to the edges of the test cage, providing most unfavorable conditions for gnawing, were untouched or damaged very slightly. Other materials, the composition of which is not disclosed, were damaged little or none although favorable gnawing edges were provided. Tests with these will be continued with variations of method before conclusions are drawn.

A perforated marine veneer material used for sound proofing, 3/16 inches in thickness and perforated with 5/32 inch holes centered 1/2 inch apart, has been exposed to sixteen rats for 42 nights. The edges of all the holes of the lower four rows, (20 holes exposed per row), all except two in each of the fifth and sixth rows, all except five of the seventh row, and scattered ones in the eighth row and above are gnawed to a greater or lesser extent. Some bear evidence of a tooth mark only, or are chipped. Many are cut approximately 1/3 the distance through the panel and gouged for a distance around the hole up to 1/4 inch beyond the edge.

An expanded metal panel having diamond-shaped meshes 5/8 inch by 1 11/16 inch was tested to determine at approximately what age and size growing rats no longer would be able to go through the meshes. The rats (Alexandrine) were born June 3, 1946. The test was set up on July 24 (rats less than two months old). They freely went back and forth through the meshes until on August 21 (age 2 months, 18 days) one hesitated for several minutes before going through. None would go through on test between the third and fifth of September. One went through on September 6 (age 3 months) after long agitation, but one of the others failed after making repeated desperate attempts.

Until September 24 frequent unsuccessful efforts were made to induce or force the rats to go through the meshes. On this date the combined weight of the three was 12 ounces (an average of four ounces).

Six samples of insulation material in blocks six inches in thickness are under test to determine whether rats would excavate tunnels in the material and use cavities thus formed for harborages and as nesting places for young. Each sample was exposed to a pair of Alexandrine rats. Two samples are pressed cork and the four others are types of fiber insulation which is irritating to the human skin. All have been under test since August 15, 1946.

Within three to twenty-four hours after the tests were set up, rats had established harborage in three of the fiber insulation samples and in one of the pressed cork samples. The tunnels through the fibrous material required the penetration of three layers of tar paper. Within the next few days all the samples were tunneled throughout and have been used as harborage continuously ever since. Six young were born on or about September 22 in a cavity of the cork insulation. They apparently were normal on September 30.

CHEMICAL INVESTIGATIONS BRANCH

W. R. Schmitz, M. B. Goette, S. B. Richter, S. L. Resnick

Chemical Deterioration of DDT in Residual Spraying

Tests have been continued to determine what factors are most influential in the deterioration of DDT applied as a residual spray. Except for the tests described in this report, the tests conducted were a continuation of those tests reported in "Summary of Activities No. 6". All techniques employed were previously reported.

As a control for the other tests, duplicate panels with 5 percent DDT in kerosene and 5 percent DDT emulsion on glass, paper, and wood surfaces were prepared and placed in the dark for a period of three months at room temperature. The panels sprayed with 5 percent DDT in kerosene showed a DDT loss of 20 to 25 percent compared to initial analyses, while the panels sprayed with 5 percent DDT emulsion showed only a slight difference compared to initial analyses.

Duplicate panels with 5 percent DDT in kerosene and 5 percent DDT emulsion on glass surface only were prepared and held for three months at a constant temperature of 40 degrees Fahrenheit. The kerosene panels showed a DDT loss of about 30 percent compared to initial analyses, but no difference compared to the control panels. The emulsion panels showed 98 percent of the DDT still remained. Apparently most of the DDT loss from the kerosene panels occurred during the first month since similar panels kept for only one month showed a DDT loss of about 25 percent compared to initial analyses.

Duplicate panels with 5 percent DDT in kerosene and 5 percent DDT emulsion on wood surface only were prepared and exposed to ultra-violet light for 248 hours, or 31 eight hour days. The kerosene-wood panels gave 46 percent recovery of DDT and emulsion-wood panels gave 77 percent DDT recovery. However, it is not sure whether the loss of DDT, which occurred on both glass and wood surfaces, was due to the ultra-violet light or to the heat produced by the lamp. Control tests are now under way to evaluate the difference.

Duplicate panels, which had previously been subjected to artificial flaking for one month, were covered with new covers and subjected to 84 additional bumps over two months. At the end of this period, less than half of one percent of the DDT had flaked off into the cover. The amount of DDT remaining on the panels was analyzed and the results showed no significant difference compared to the control panels. Similar panels with 5 percent DDT in kerosene and 5 percent DDT emulsion on glass, paper, and wood surface were prepared and placed in an occupied house for three months. These panels were subject to all natural conditions, but showed only half of one percent of the DDT had flaked off into the cover. It was concluded that flaking of DDT applied as a residual spray occurred in only a very small amount.

The effect of humidity was tested by placing duplicate panels with 5 percent DDT in kerosene and 5 percent DDT emulsion on glass surface, in both dry air and saturated air for three months. Little difference was detected between panels subjected to dry air and saturated air, and the recovery of DDT from these panels was essentially the same as the control panels. Thus, little effect of humidity on DDT was detected.

The effect of cleaning the glass, paper and wood surfaces was tested by washing the glass and wood surfaces with a wet soapy rag, and the paper surface was cleaned by use of a commercial wallpaper cleaner. Duplicate panels with 5 percent DDT in kerosene and 5 percent DDT emulsion were prepared. The panels were left exposed to the open air so that dust and dirt would settle on each one. After one week, all panels were cleaned, and one set consisting of duplicate panels of kerosene and emulsion on glass, paper and wood surfaces were removed for analyses. The other panels were put back for another week. After the second week, all remaining panels were again cleaned, and a second set of panels removed for analysis. The remaining panels were put back for another week. After the third week, the panels, which were left, were cleaned and analyses made. Thus, each panel was cleaned one, two or three times. On the glass surface, almost all of the DDT was removed the first time. The kerosene- and emulsion-paper panels showed little difference between the first, second, and third cleanings. A total of about 10 or 15 percent DDT was lost by cleaning the paper surfaces three times in this manner. The kerosene-wood panels showed a loss of DDT of roughly 20 percent between each cleaning. The emulsion-wood panels lost very little DDT after one cleaning and only about 10 percent DDT loss after three cleanings. Thus, it appears that wallpaper sprayed with DDT can be cleaned without removing much of the DDT. Likewise, wood surfaces sprayed with the DDT emulsion can be washed without removing much of the DDT. Whether or not the remaining DDT is effective in killing insects will have to be tested biologically.

To determine what effect flies (Musca domestica) had in removing residual DDT, two tests were made. Using standardized technique, the panels in test A were exposed for 60 minutes to approximately 100 flies twenty times over a period of four months. Both 5 percent DDT in kerosene and 5 percent DDT emulsion on glass, paper, and wood surfaces were tested. In test B, exactly the same procedure was followed except that no flies were used. All movement of panels and methods used were identical in the two tests except one test used flies and the other test did not. In test A, no records were made of the mortality of flies until the end of the fourth month. Then on duplicate 15 minute exposures, very poor mortality was obtained on all panels except emulsion-wood. Originally, these same panels had all given very high mortality. All panels in tests A and B were then analyzed for DDT, and a comparison made between the corresponding panels in each test. Only on kerosene-glass panels were there any significant differences between tests A and B, only 16 percent DDT was recovered in test A, while 52 percent DDT was recovered in test B. All other panels had essentially the same amount of DDT left as did the control panels. Thus, the large drop in toxicity is probably due to masking of the DDT, and tests are now in progress to determine what kind of masking occurs.

Effect of activity by adult Anopheles quadrimaculatus mosquitoes on DDT was tested by the standardized technique used in making regular biological tests. At the end of two months, the mortality was compared with the amount of DDT remaining on the panels. Both 5 percent DDT in kerosene and 5 percent emulsion on glass, paper, and wood surfaces were tested.

Highest mortality (75 to 80 percent) occurred on kerosene- and emulsion-wood surfaces, and lowest mortality (40 to 45 percent) occurred on kerosene- and emulsion-glass panels. However, all panels except kerosene-glass showed that better than 80 percent of the DDT remained on the panels. Because of the high recovery of DDT and drop in toxicity, this is another indication that masking of DDT occurs.

In all of the tests made, better recovery of DDT was obtained when using the emulsion form rather than the kerosene solution. The recovery of DDT from kerosene-glass panels was always the lowest. Factors which are of little importance in chemical deterioration of DDT in residual spraying are cool temperatures around 40 degrees Fahrenheit, flaking of DDT, humidity, cleaning of paper and wood surfaces, and insect activity. The most outstanding factor in causing loss of DDT was temperature around 140 degrees Fahrenheit. Masking of the DDT also appears quite important in causing low toxicity to *Musca domestica* flies and *Anopheles quadrimaculatus* mosquitoes. Ultra-violet light is at present of undetermined importance.

Table 20 presents a summary of the results obtained at the end of the third month.

Penetration of DDT into Wood Surfaces

A study has been undertaken to determine what effect wetting of wood surface with water would have on penetration of DDT into the wood. Poplar wood panels, 3 inches by 12 inches, were selected and sprayed by means of a micro-sprayer described previously in "Summary of Activities No. 6". Two sprayers were set up so that panels could be sprayed first with water

Table 20. Chemical determination of DDT in residual spraying (50 mg. DDT per panel except in #5 which had 25 mg.)

Description of Test		5% DDT in	Surface	Amount of Panel Analyzed	Duration of Test	Dosage DDT Recovered	Percent DDT Recovery
1. Control Panels. Kept in dark place at room temperature. Run in duplicate		Kerosene	Glass	All	3 mons.	37.0 mg	74%
		Kerosene	Paper	Top layer	3 mons.	35.1 mg	70%
		Kerosene	Wood	1/8 inch	3 mons.	36.2 mg	72%
		Emulsion	Glass	All	3 mons.	47.5 mg	95%
		Emulsion	Paper	Top layer	3 mons.	45.0 mg	90%
		Emulsion	Wood	1/8 inch	3 mons.	49.0 mg	98%
2. Held at constant temperature of $40^{\circ}F$. Run in duplicate.		Kerosene	Glass	All	3 mons.	34.0 mg	68%
		Emulsion	Glass	All	3 mons.	49.0 mg	98%
3. Exposed to ultra-violet light in 8 hour intervals. Run in duplicate		Kerosene	Wood	1/8 inch	248 hrs. or	23.1 mg	46%
		Emulsion	Wood	1/8 inch	31-8 hr. days	38.5 mg	77%
4A. Flaking test Run in duplicate Artificial flaking	(a) Each panel covered. Subjected to 84 severe artificial bumps. Dosage DDT recovered is actual amount of DDT flaked off each panel.	Kerosene	Glass	Only cover was analyzed	2 mons.	0.14 mg	0.3%
		Kerosene	Paper		2 mons.	0.18 mg	0.4%
		Kerosene	Wood		2 mons.	0.09 mg	0.2%
		Emulsion	Glass		2 mons.	0.11 mg	0.2%
		Emulsion	Paper		2 mons.	0.10 mg	0.2%
		Emulsion	Wood		2 mons.	0.09 mg	0.2%
	(b) Amount Remaining on panels after test "a"	Kerosene	Glass	All	3 mons.	31.8 mg	64%
		Kerosene	Paper	Top layer	3 mons.	45.5 mg	91%
		Kerosene	Wood	1/8 inch	3 mons.	33.0 mg	66%
		Emulsion	Glass	All	3 mons.	39.2 mg	78%
		Emulsion	Paper	Top layer	3 mons.	50.5 mg	101%
		Emulsion	Wood	1/8 inch	3 mons.	44.0 mg	88%
4B. Flaking tests Run in duplicate Natural flaking in occupied house.	(a) Each panel covered; nailed to wall of an occupied house. Dosage DDT recovered is actual amount of DDT flaked off each panel.	Kerosene	Glass	Only cover was analyzed	3 mons.	0.26 mg	0.5%
		Kerosene	Paper		3 mons.	0.12 mg	0.2%
		Kerosene	Wood		3 mons.	0.08 mg	0.2%
		Emulsion	Glass		3 mons.	0.08 mg	0.2%
		Emulsion	Paper		3 mons.	0.08 mg	0.2%
		Emulsion	Wood		3 mons.	0.06 mg	0.1%

Table 20. Chemical determination of DDT in residual spraying (50 mg. DDT per panel except in #5 which had 25 mg.)- - - - (continued)

Description of Test		5% DDT in	Surface	Amount of Panel Analyzed	Duration of Test	Dosage DDT Recovered	Percent DDT Recovery
4B.	(b) Amount remaining on panels after Test "a"	Kerosene	Glass	All	3 mons.	28.1 mg	56%
		Kerosene	Paper	Top layer	3 mons.	-	-
		Kerosene	Wood	1/8 inch	3 mons.	35.1 mg	70%
		Emulsion	Glass	All	3 mons.	34.8 mg	70%
		Emulsion	Paper	Top layer	3 mons.	-	-
		Emulsion	Wood	1/8 inch	3 mons.	36.4 mg	73%
5. Humidity Tests.	Exposed to dry air at room temperature in dark place.	Kerosene	Glass	All	3 mons.	17.5 mg	70%
		Emulsion	Glass	All	3 mons.	22.4 mg	90%
Run in Duplicate	Exposed to saturated air at room temperature in darkplace.	Kerosene	Glass	All	3 mons.	16.6 mg	66%
		Emulsion	Glass	All	3 mons.	23.7 mg	95%
6. Cleaning Tests Glass and wood surfaces wiped clean with wet soapy cloth. Paper surface cleaned by use of a commercial wall paper cleaner. Each cleaned once a week Run in duplicate		Kerosene	Glass	All	1 week	0.15 mg	0.3%
		Kerosene	Glass	All	2 weeks	0.12 mg	0.2%
		Kerosene	Glass	All	3 weeks	0.05 mg	0.1%
		Kerosene	Paper	Top layer	1 week	39.5 mg	79%
		Kerosene	Paper	Top layer	2 weeks	41.5 mg	83%
		Kerosene	Paper	Top layer	3 weeks	37.5 mg	75%
		Kerosene	Wood	1/8 inch	1 week	36.0 mg	72%
		Kerosene	Wood	1/8 inch	2 weeks	28.3 mg	57%
		Kerosene	Wood	1/8 inch	3 weeks	16.0 mg	32%
		Emulsion	Glass	All	1 week	0.15 mg	0.3%
		Emulsion	Glass	All	2 weeks	0.13 mg	0.3%
		Emulsion	Glass	All	3 weeks	0.07 mg	0.1%
		Emulsion	Paper	Top layer	1 week	44.5 mg	89%
		Emulsion	Paper	Top layer	2 weeks	37.5 mg	75%
		Emulsion	Paper	Top layer	3 weeks	39.3 mg	79%
		Emulsion	Wood	1/8 inch	1 week	46.0 mg	92%
		Emulsion	Wood	1/8 inch	2 weeks	38.5 mg	77%
		Emulsion	Wood	1/8 inch	3 weeks	41.7 mg	83%

Table 20. Chemical determination of DDT in residual spraying (50 mg. DDT per panel except in #5 which had 25 mg.) - - - - (continued)

Description of Test		5% DDT in	Surface	Amount of Panel Analyzed	Duration of Test	Dosage DDT Recovered	Percent DDT Recovery
7A. Twenty 60 minute exposures of approximately 100 (Musca domestica) flies	Mortality, 15 min. exposure						
	1%	Kerosene	Glass	All	4 mons.	8.1 mg	16%
	1%	Kerosene	Paper	Top layer	4 mons.	48.0 mg	96%
	26%	Kerosene	Wood	1/8 inch	4 mons.	30.0 mg	60%
	1%	Emulsion	Glass	All	4 mons.	39.5 mg	79%
	0%	Emulsion	Paper	Top layer	4 mons.	46.5 mg	93%
	82%	Emulsion	Wood	1/8 inch	4 mons.	45.5 mg	91%
7B. Followed identical procedure of "7A", except there were no flies used.		Kerosene	Glass	All	4 mons.	26.0 mg	52%
		Kerosene	Paper	Top layer	4 mons.	46.5 mg	93%
		Kerosene	Wood	1/8 inch	4 mons.	35.0 mg	70%
		Emulsion	Glass	All	4 mons.	40.5 mg	81%
		Emulsion	Paper	Top layer	4 mons.	48.5 mg	97%
		Emulsion	Wood	1/8 inch	4 mons.	42.5 mg	85%
8. Routine testing of Anopheles quadrimaculatus adults.	Mortality, 60 min. exposure						
	45%	Kerosene	Glass	All	2 mons.	25.0 mg	50%
	52%	Kerosene	Paper	Top layer	2 mons.	41.0 mg	82%
	75%	Kerosene	Wood	1/8 inch	2 mons.	40.5 mg	81%
	40%	Emulsion	Glass	All	2 mons.	42.0 mg	84%
	56%	Emulsion	Paper	Top layer	2 mons.	49.5 mg	99%
	82%	Emulsion	Wood	1/8 inch	2 mons.	44.5 mg	89%

and then immediately with DDT. Two depths of wood, less than 0.001 inch and 0.005 ± 0.002 inch, were removed by a hand scraper. The DDT was extracted with benzene, and a colorimetric method of analysis was used to analyze DDT.

In test No. 1, panels were sprayed with one milliliter of 5 percent DDT in kerosene and 5 percent DDT emulsion. All tests were run in quadruplicate. In tests No. 2, 3 and 4, the panels were sprayed first with 1, 2 or 4 milliliters of water and then immediately sprayed with one milliliter of 5 percent DDT in kerosene or 5 percent DDT emulsion. In test No. 5, the panels were sprayed first with 4 milliliters of water and then allowed to stand for 15 minutes before spraying the panels with one milliliter of 5 percent DDT in kerosene or 5 percent DDT emulsion. In all tests, after the DDT had been applied, the panels were allowed to dry fully before any of the DDT was removed by scraping.

From the results obtained, it seems disadvantageous to apply a DDT spray immediately after the wood has been wet with water. Much better results were obtained if the wood surface was wet and then allowed to stand for awhile before applying the DDT. Considerable "run-off" occurred on the panels which were wet with 4 milliliters of water and immediately sprayed with DDT. The data is summarized in table 21.

Recovery Of DDT From Ten Percent DDT Pyrophyllite Dust.

At the request of UNRRA (which encountered the situation in which the only DDT available was as a dust) an attempt was made to recover the DDT from a 10 percent DDT pyrophyllite dust. The following methods were tried:

Table 21. Recovery of DDT from Wood Surface immediately after spray had dried thoroughly.

Test Conditions	5% DDT in KEROSENE		5% DDT EMULSION	
	Depth of Wood Removed		Depth of Wood Removed	
	<0.001 inch	0.005"±0.002"	<0.001 inch	0.005"±0.002"
1. Dry Surface. Panel sprayed with one milliliter of 5% DDT solution.	30%	50%	38%	73%
2. Panel sprayed with one milliliter of water and immediately sprayed with one milliliter of 5% DDT solution.	25%	57%	27%	67%
3. Panel sprayed with two milliliters of water and immediately sprayed with one milliliter of 5% DDT solution.	40%	56%	37%	86%
4. Panel sprayed with four milliliters of water and immediately sprayed with one milliliter of 5% DDT solution.	29%	45%	28%	65%
5. Panel sprayed with four milliliters of water and after 15 minutes sprayed with one milliliter of 5% DDT solution.	47%	70%	51%	93%

Note: Each figure is an average of four panels.

To 25 gram and 50 gram samples of the dust, 100 milliliters of xylene, kerosene, or #2 fuel oil were added and the mixtures were ... for 30 minutes. After standing for one hour, the DDT-oil layer was ... Although 100 milliliters of solvent were added, it was impossible ... all of the solvent. The amount of solvent which could be recovered ...ded under the column "Recovery of DDT Solution" as the percent of ...nal amount of solvent added. The efficiency of the solvent in dis- ... under these experimental conditions is shown by the percent DDT ... 100 ml. of solvent extracted 100 percent of the DDT ... dust, the solution would contain 2.5 ... solvent extracted only 80 percent of the ... DDT dust, the solution would contain ...otal DDT Recovery" is the total percent ...cent DDT dust extracted. It is the ... and the percent efficiency of the sol- ...ulated in table 22.

... the less solution was recovered ... solvent.

...xcess of water before adding the ... of the solution was obtained ... to wet the dust instead of the

...rs of water for 10 minutes, ...dded and the combination ...eparation was obtained.

Table 22. Recovery of DDT from a 10 percent DDT-Pyrophyllite Dust.

Solvent	Amount of Dust	Recovery of DDT Solution	Percent DDT in Solution	Total DDT Recovery
Toluene	25 gms	69%	2.4%	65%
Toluene	50 gms	30%	4.7%	28%
Xylene	25 gms	60%	1.6%	38%
Xylene	50 gms	26%	3.1%	16%
Kerosene	25 gms	42%	1.9%	32%
Kerosene	50 gms	25%	3.8%	19%
#2 Fuel Oil	25 gms	56%	1.9%	43%
#2 Fuel Oil	50 gms	20%	3.8%	15%

Table 23. Recovery of DDT from a water-soaked dust containing 10 percent DDT in pyrophyllite.

Solvent	Amount of Dust	Recovery of DDT Solution	Percent DDT in Solution	Total DDT Recovery
Toluene	25 gms	74%	2.2%	65%
Xylene	25 gms	68%	2.2%	59%
Kerosene	25 gms	86%	1.9%	66%
#2 Fuel Oil	25 gms	65%	1.9%	50%

The dust settled on the bottom with the water layer between the dust and the solvent layer. After standing for one hour, the liquid layers were poured off and the DDT-oil solution was decanted. It was noted that the water must be mixed with the dust before adding the solvent or else a very poor separation occurred. The results are tabulated in table 23.

3. By adding salt, at the rate of 1 gram per 100 milliliters of water, to the water in the initial step in procedure #2, a better recovery of both solvent and DDT was obtained in all cases except with the fuel oil. The results are tabulated in table 24.

Table 24. Recovery of DDT from a salt water-soaked dust containing 10 percent DDT in pyrophyllite.

Solvent	Amount of Dust	Recovery of DDT Solution	Percent DDT in solution	Total DDT Recovery
Toluene	25 gms	80%	2.5%	80%
Toluene	50 gms	72%	5.0%	72%
Xylene	25 gms	75%	2.5%	75%
Xylene	50 gms	61%	4.8%	59%
Kerosene	25 gms	93%	2.2%	82%
Kerosene	50 gms	88%	4.7%	84%
#2 Fuel Oil	25 gms	76%	1.4%	42%
#2 Fuel Oil	50 gms	70%	2.4%	34%

The best recovery of DDT solution and the maximum efficiency of the solvent in dissolving DDT from a 10 percent DDT pyrophyllite dust was obtained by the use of procedure 3.

EQUIPMENT DEVELOPMENT BRANCH

H. Stierli, J. D. Parkhurst[10/]

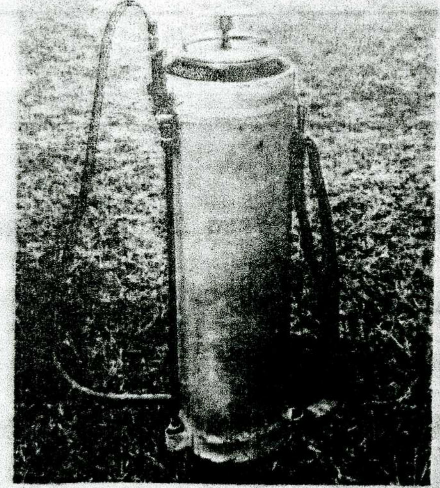
Aluminum Spray Can for DDT Residual Application.

To facilitate field operations and to lengthen the useful life of compressed air spray cans, a model four gallon capacity sprayer has been constructed for use with an outside air source. The spray can is fabricated of aluminum for both lightness and resistance to corrosion from emulsions of DDT.

An oval filler opening is provided in the bottom of the sprayer. The cover is fitted to slip inside of the tank as shown in plate 1 a, b and c. When in the closed position (see plate 1 d) the cover gasket is inside of the tank. After charging the sprayer with liquid, the can is inverted and the filler opening truly becomes the bottom. This allows the cover gasket to be submerged in liquid and thereby aiding in the pressure seal. The internal pressure in the can augments the mechanical sealing pressure furnished by the exterior spring clamp.

The air inlet consists of a conventional tire tube valve with fitting screwed into the top of the sprayer (see plate 1 e). The spray outlet extends from the bottom to the top of the can and is soldered to a screw fitting with hose connection. Both openings in the top are "bossed" to allow adequate thickness for threaded fittings. A metal handle is fitted tothe top in order to ease carrying of the sprayer. The spray hose is 1/4" I.D. by 4 feet long with "Thiokol" inner lining, one braid

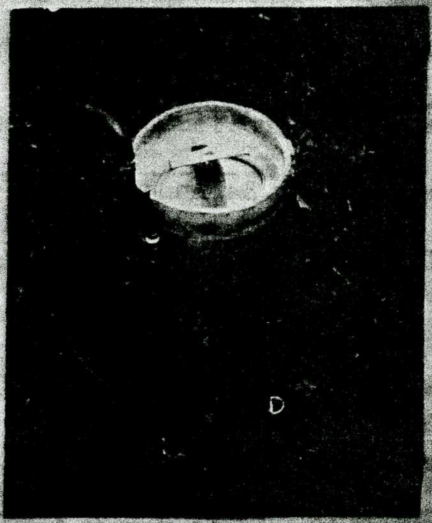
10/ Resigned August 10, 1946.



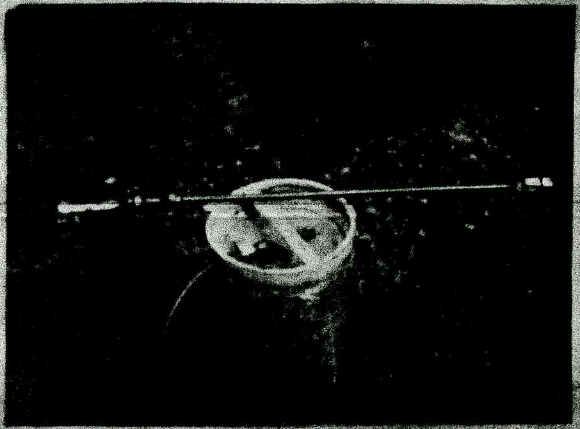
a - Sprayer, bottom side up.

b - Sprayer bottom, showing oval filler opening and cover.

c - Sprayer bottom, showing placement of cover in filler opening.



d - Sprayer bottom, showing filler cover in closed position.



e - Sprayer top, showing air inlet, carrying handle, spray outlet, hose, shut-off valve, wand, and nozzle.

f - Sprayer, ready for use.

Plate 1. Compressed air aluminum sprayer of 4 gallon capacity for use with an outside air source.

of cord, and an outer rubber cover. The conventional shut-off valve wand and nozzle are used. Plate 1 a shows the clip and cup for holding the wand and nozzle when not in use. A comfortable carrying strap is provided. Plate 1 f shows the sprayer ready for use.

The cylindrical shell of the spray can is formed from 24 ST aluminum .051 inches thick. The ends are of 24SO aluminum 0.250 inches thick. All seams and joints are gas welded; however, it is likely that electric resistance welding would be employed in commercial production. The can was hydrostatically tested with 120 psi pressure. Recommended maximum working pressure is 60 psi. The total weight of the sprayer empty is 9 1/2 pounds.

The sprayer was field tested with five percent DDT-xylene emulsion. A normal filling of 1 3/4 gallons spray was satisfactorily discharged with an initial pressure of 55 psi pressure. A 2 gallon liquid charge requred 60 psi pressure to empty the tank with good spray pattern.

EQUIPMENT EVALUATION

H. Stierli, J. D. Parkhurst[11/], W. R. Schmitz and R. W. Fay

Centrifugal Fan Type Sprayer Constructed From A Power Duster.

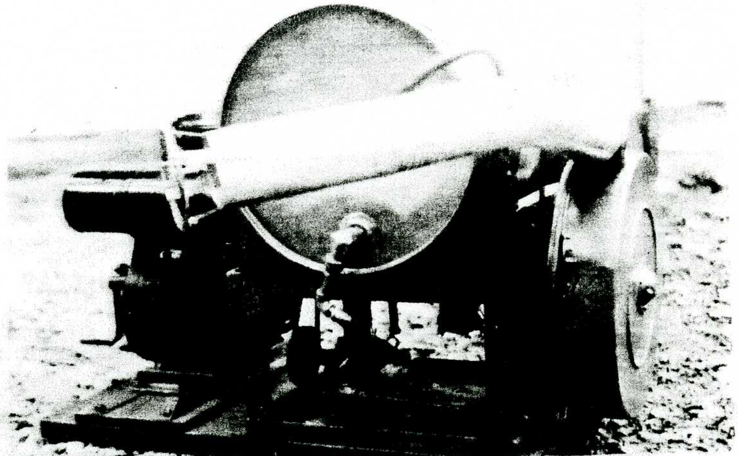
The Engineering Division of the Communicable Disease Center requested construction of a space sprayer for dispersal of DDT in areas endangered with poliomyelitis. Since turbine type air blast sprayers were not yet available, it was desired to convert a power duster for immediate use.

Equipment

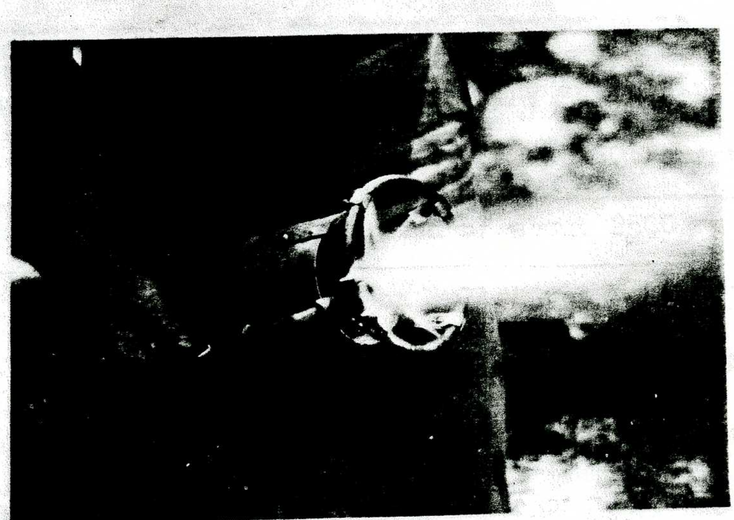
The largest power duster available was Root Model ZA-1 with 4 inch diameter outlet fan and 5 H.P. gasoline engine. The dust hopper was removed and replaced with a 30 gallon metal drum, (see plate 2 a). The fan outlet was extended with a 4 inch diameter flexible metal tube terminating with a straight discharge section 10 inches in length and permitting approximately 60° movement. A 5 inch inside diameter nozzle ring of 3/8 inch copper tubing was mounted 2 1/4 inches out from the discharge section (see plate 2 b). This ring contained several equally spaced holes for injection of sprays into the air stream. The sprays met in the form of a cone with the peak directed against the air flow and forming an angle of about 120°.

A rotary gear pump of 1/2 inch outlet size was installed on the unit with a V-belt drive from the fan shaft. This pump was fitted with a special

11/ Resigned August 10, 1946.



a - Close-up of centrifugal fan type sprayer.



b - Nozzle ring, showing excellent break-up of liquid by the air blast from fan.

c - Sprayer mounted on truck for city dump treatment.

Plate 2. Centrifugal fan type sprayer constructed from a power duster.

shaft packing "Allpax" for resistance to both water and oils. A 50 mesh, 3/4 inch size strainer was connected between the tank and pump inlet. The pump outlet was piped to the nozzle ring and also to an adjustable bypass valve for return of liquid to the tank. In order to agitate water-wettable sprays and aqueous emulsions, the bypass connection in the tank was fitted with a 1/2 inch inside diameter copper tubing containing seventeen 5/32 inch diameter holes equally spaced in two rows 150° apart from each other.

To obtain a satisfactory fan speed of about 2500 rpm without excessive engine speed, the 5 inch diameter fan pulley was replaced with one of 4 inch diameter. This allows the engine to operate at 1800 rpm without overloading. The pump speed is roughly 1250 rpm. Pump pressure may be varied from 50 to 80 psi to obtain the desired rate of discharge with the nozzle rings furnished.

Several methods of injection of the insecticide into the air blast were tested. Arrangements utilizing standard fan pattern and conical pattern atomizing nozzles failed to give satisfactory dispersal. The sprays from these nozzles either struck the opposite wall of the discharge tube and thereby caused drooling, or some of the spray particles passed through the air blast without being picked up by it. The nozzle ring arrangement with sprays meeting in the form of a cone produced satisfactory break-up for dispersal by the air blast with a minimum of drooling.

Three nozzle rings of varying capacity were constructed. The first contains seven holes bored with a number 68 drill and discharges one gpm at 50 psi pressure. The second has six holes of number 56 drill size and discharges two gpm at the same pressure. The third delivers one-half gpm at 50 psi pressure and contains four holes of number 68 drill size.

The sprayer was mounted on the bed of a weapon carrier truck (see plate 2 c) so that the fan outlet was directed perpendicular to the direction of motion of the vehicle. For treatment of alley and similar conditions the sprayer might best be mounted with the fan outlet directed toward the rear of the truck.

Preliminary Tests at the Savannah City Dump.

The sprayer unit was field tested at the Savannah City Dump on July 30 utilizing a 6 acre plot heavily infested with adult flies. In order to obtain an output dosage of one pound DDT per acre 14 gallons of 5 percent DDT aqueous emulsion were dispersed through the nozzle ring with discharge rate of one gpm. Four swaths were applied using a truck speed of 2 to 3 mph. The spray was directed perpendicular to movement of the wind for about two-thirds of the plot and downwind over the remainder of the area. The wind velocity ranged from 2 to 10 mph during the test. The spray was observed to carry 50 to 100 feet perpendicular to the wind and several hundred feet downwind.

Observation shortly after treatment showed that the flies were affected by the spray application. Unfortunately heavy rains during the remainder of the day nullified quantitative biological data. However, distribution of spray was quite good and the effectiveness appeared equivalent to airplane treatment at the same dosage.

The nozzle ring with 2 gpm rate of discharge was also used at the Savannah City Dump. Observation showed the performance to be similar to that of the 1 gpm capacity nozzle. The greater rate of discharge enabled more rapid treatment of the area when using the 5 percent emulsion. Due to continued unfavorable weather conditions it was not possible to obtain significant biological data on this treatment.

Particle Size and Distribution.

Employing downwind dispersal with the wind velocity somewhat less than one mph, a 5 percent DDT emulsion was discharged at 2 gpm with a vehicle speed of approximately 3 mph. Two rows of ten carbon coated slides each were placed perpendicular to the movement of the truck at intervals of 20 feet and the first slide 10 feet downwind from the vehicle. Table 25 shows the particle size and area dose as a function of distance for the above conditions:

Table 25. Particle size and area dose at various distances from Fan Type Sprayer.

Distance (feet)	Particle Size* (MMD in microns)	Area Dose* (lbs DDT/acre)
10	152	0.045
30	167	1.185
50	143	0.665
70	120	0.321
90	83	0.063
110	84	0.024
130	76	0.005
150	57	0.005
170	30	0.003
190	25	0.001

*Average of two slides.

Based on a swath 200 feet in width the output dosage was 1.2 lbs. DDT per acre. From the above data roughly 20 percent recovery is indicated. The actual recovered dosage is probably greater since it is likely that some evaporation of water occurred after injection of the emulsion into the air blast.

It is believed that an effective swath of 50 feet could be used with a no wind condition, 100 feet with a steady breeze of 1 to 2 mph velocity, and 200 feet with winds 2 to 6 mph velocity.

Buffalo Turbine Blower

A combination Buffalo Turbine Sprayer-Duster (Type 1) unit, manufactured by the Agricultural Equipment Co., Inc., Gowanda, N. Y., has been given preliminary evaluation for residual field applications. This unit consists of a gasoline driven motor developing about 18 H. P., axial-flow turbine, spray pump, spray tank and dust hopper mounted on a frame and having a total over-all weight of approximately 800 lbs. Standard attachments consisted of (a) a blower extension with a ring type nozzle and a circular aperture, and (b) a blower extension with a straight tube nozzle and a rectangular aperture.

Calibration of the spray tank capacity showed an average increment of .52 inch per gallon on a measuring stick. With 50 gallons content the liquid level stood 1.07 inches from the top of the tank. It was found necessary to remove all paint from the interior of the spray tank before a 5 percent DDT-xylene emulsion containing approximately 14 percent xylene could be used. The emulsion caused immediate sloughing of the paint film.

Calibration of the nozzle delivery rate using water is shown in table 26.

Table 26. Physical data on discharge from Buffalo Turbine Blower.

Type Nozzle	Motor Speed	Pressure (psi)	Delivery	Time (Min.)	Calibration
Ring	1/2 throttle	15	6.6 gal.	2	3.3 gpm
Ring	full throttle	17	8.0 gal.	2	4.0 gpm
Straight	1/2 throttle	14	5.0 gal.	2	2.5 gpm
Straight	full throttle	16	5.6 gal.	2	2.8 gpm

An effort was made to determine the type of spray distribution obtained with the use of the rectangular aperture and the circular aperture attachments of the turbine blower both for the horizontal position and for the elevated 45° position with the elevation control handle in a vertical position. One run using 5 percent DDT-xylene-Triton X-100 emulsion, was made in each case and meteorological data and slide counts were made for each run. The blower was mounted on a one ton International truck so that the spray apertures stood about 7 - 8 feet from the ground. The truck moved at right angles to the wind for a distance of 200 feet and two series of slides were placed parallel to the wind, the rows 75 feet apart near the center of the run. The ten slides were at 20 foot intervals with the first slide ten feet from the line of run. All runs were made at 1/2 throttle blower speed with the spray directed downwind.

Conditions and results of the test are shown in tables 27 and 28.

Table 27. Physical data for biological tests of Buffalo Turbine Blower.

Test No.	Start Time	Elapsed Time	Truck Speed	Wind Speed	T_6-T_1	Nozzle	Amount Delivered	Rate of Delivery
1	1:30 P.M.	43 sec.	3.17 mph.	9.4 mph. S.E.	-.5	Rectangular Horizontal	2.5 gal.	3.5 gpm
2	2:00 P.M.	46 sec.	3.00 mph	3.6 mph S.E.	-.5	Rectangular 45°	1.66gal.	2.2 gpm
3	2:10 P.M.	43 sec.	3.17 mph.	6 mph S.E.	-1.5	Ring Horizontal	2.16gal.	2.75gpm
4	2:15 P.M.	40 sec.	3.4 mph.	6.8 mph S.E.	-.5	Ring 45°	2.83gal.	4.25gpm

Fly control tests (field).

For a practical fly control test the Buffalo turbine blower was tried on the city dump of Savannah, Ga. The test was made at 9:30 A.M. under the following conditions: wind NE to ENE 2.8 to 3.3 mph., temperature conditions $T_6-T_1=84.1 - 86.7 = -2.6$, generally clear and bright. The application was made with the rectangular opening in the horizontal position and the straight type nozzle. The blower motor was operated at 1/2 throttle speed and 5 percent DDT-Triton X-100 - xylene emulsion was used.

The dump area and surrounding vegetation, about 25 acres, were treated with 38 gallons of 5 percent emulsion spray or at an approximate dosage of .6 lb. DDT per acre. Grill counts previous to treatment showed average counts of 7 houseflies, 6 *Cochliomyia macellaria* and 9 *Lucilia* spp. per grill. Immediately after treatment the counts of *Musca* and *Lucilia* were

Table 28. Recovered DDT dosage and mass median diameter obtained in blower turbine calibrations with straight and ring nozzle attachments in horizontal and 45° upward positions.

	Test #1		Test #2		Test #3		Test #4	
Distance	MMD	Area Dose lb/acre	MMD	Area Dose lb/acre	MMD	Area Dose lb/acre	MMD	Area Dose lb/acre
10 ft.	218 mu	0.243	105 mu	.236	101 mu	.010	0 mu	0
30	139 mu	0.275	173 mu	.222	142 mu	.149	115 mu	.028
50	115 mu	0.199	115 mu	.063	113 mu	.057	144 mu	.124
70	120 mu	0.159	121 mu	.039	101 mu	.056	130 mu	.067
90	107 mu	0.049	110 mu	.048	98 mu	.032	127 mu	.052
110	87 mu	0.013	110 mu	.096	93 mu	.028	124 mu	.062
130	100 mu	0.067	117 mu	.036	89 mu	.027	109 mu	.036
150	99 mu	0.054	114 mu	.016	69 mu	.019	114 mu	.040
170	88 mu	0.025	132 mu	.031	42 mu	.005	106 mu	.027
190	87 mu	0.041	130 mu	.020	40 mu	.003	127 mu	.035
	Straight nozzle		Straight nozzle		Ring nozzle		Ring nozzle	
	Horizontal		45° upward		Horizontal		45° upward	

markedly reduced in areas which received adequate treatment but in portions of the dumping area over 30 feet upwind from the blower nozzle very little effect was noted even immediately after application. The control lasted only about 24 hours and was then overcome by new fly replacements from dump breeding. There were indications that some of the nozzle orifices were becoming plugged by the end of the application.

Results from this type of equipment will be varied by the direction and velocity of the wind at the time of application and this will limit to some extent the value of the blower.

APPROVED:

S W Simmons

S. W. Simmons, Sanitarian (R)
Chief
Technical Development Division

23 October 1946

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